IF THE BOT FITS…DRIVE IT? JUDGMENTS OF PASS-ABILITY VS. DRIVE-ABILITY

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Background problem

- After 9/11, researchers used robots to assist rescue operations. (Casper, 2002; Murphy, 2004)
  - Marked the first civilian use of tele-operated robots in this capacity (Burke, Murphy, Rogers, Lumelsky & Scholtz, 2004)
  - Frequent reports of robots becoming stuck (Casper, 2002)

What has gone before

- Previous research indicates that people make fairly accurate pass-ability judgments (Moore, Gomer, Bulter & Pagano, 2007; Moore & Pagano, 2006)
  - Manipulated robot size
  - Camera height
  - Distance between the aperture and the robot

Why do robots get stuck?

- One possibility is that tele-operators are unable to drive the robot unfettered through apertures that are wider than the robot.
  - They can tell that the aperture is wider than the robot, but they still can't drive the robot through

Addressing drive-ability

- Jones and Johnson (2008) took pass-ability judgments a step further by having participants attempt to drive the robot through the aperture following their pass-ability judgment
  - Found that pass-ability judgments were accurate
  - Operators frequently drove the robot into pass-able apertures

Experiment

- Replicated Jones and Johnson (2008)
  - extended the research by testing operator's abilities to judge whether they can drive a robot through a given aperture

Method

- Participants
  - 34 students (27 female)
  - Ages ranged from 18-40, (M=20.61, SD=3.87)
  - Corrected to normal vision
  - No known muscular disorders

Method

- Apparatus
  - Desktop Rover, equipped with a camera

  - Small portable color television, 3 inch display
  - Apertures of varying width
    - 5 wider: 3.63, 3.38, 3.13, 2.88, 2.63 inches
    - 5 more narrow: 2.13, 1.88, 1.63, 1.38, 1.13 inches

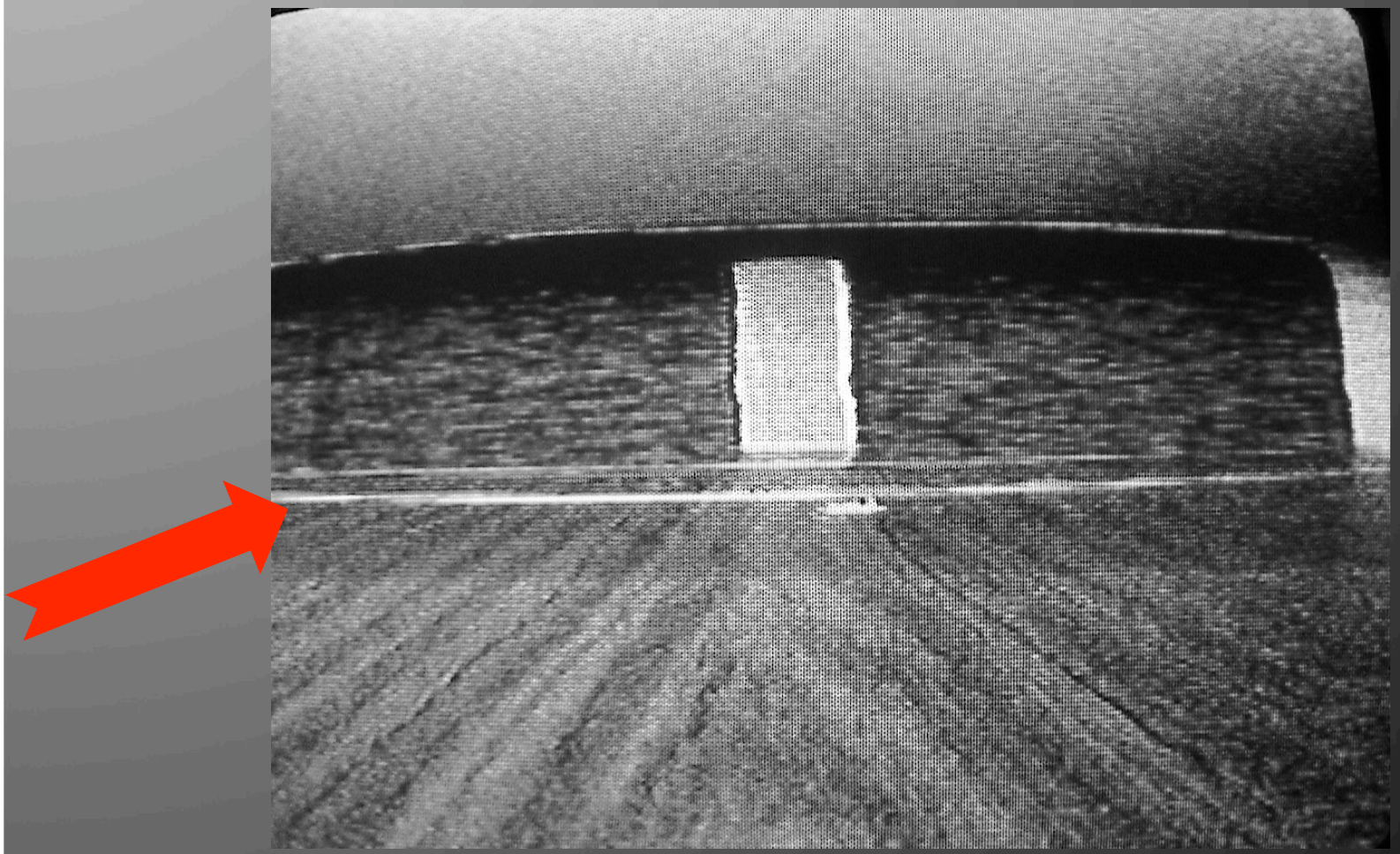
Procedure

- Participants run individually in hour long sessions
  - Able to practice prior to beginning trials
- Robot placed behind a curtain out of view during the trials
  - Had to control the robot through a small TV monitor

Procedure cont.

- Completed 7 blocks with 14 apertures
  - 5 larger, 5 smaller, 4 filler
  - Placed directly in front of aperture every time

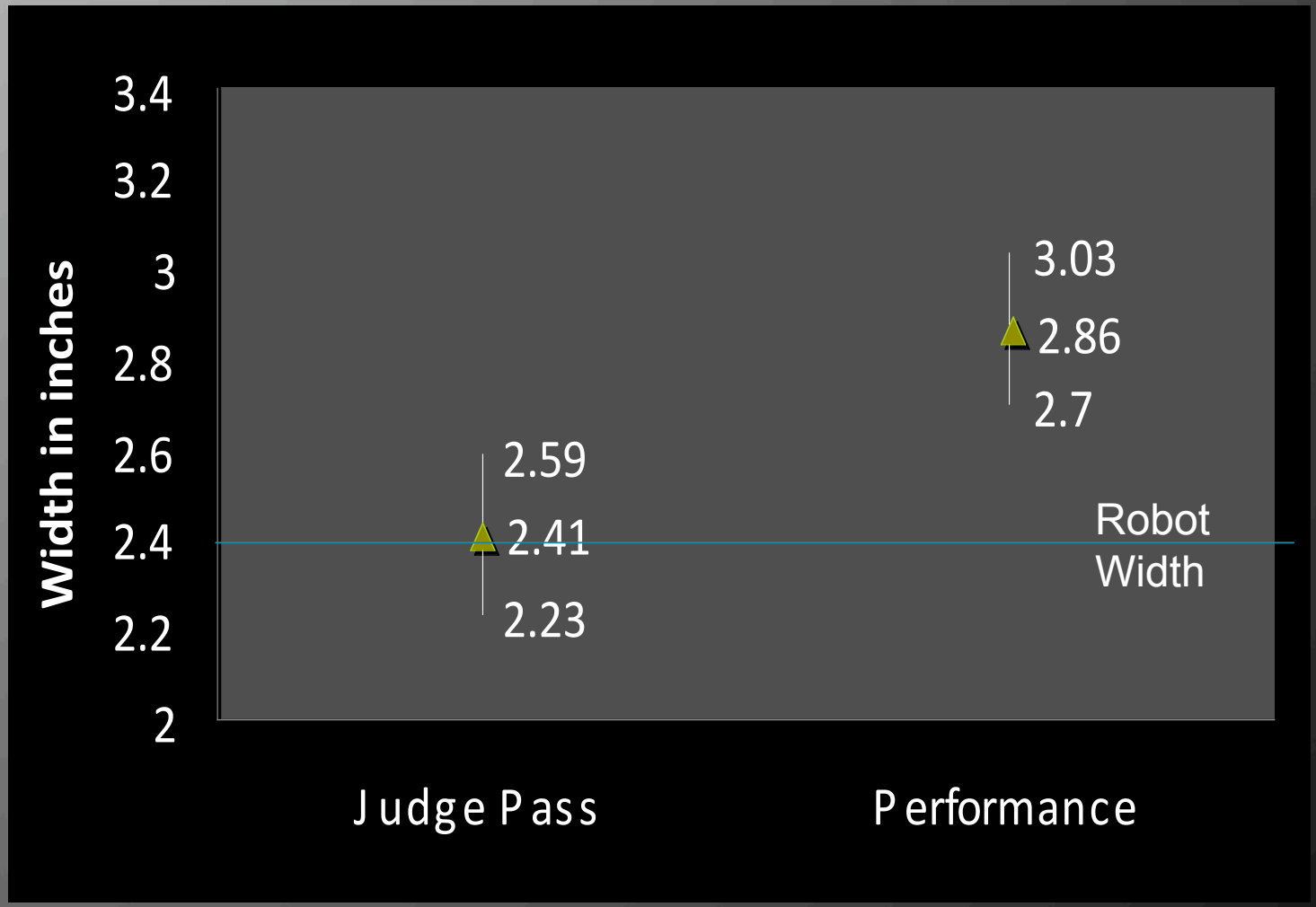
Robot-eye view



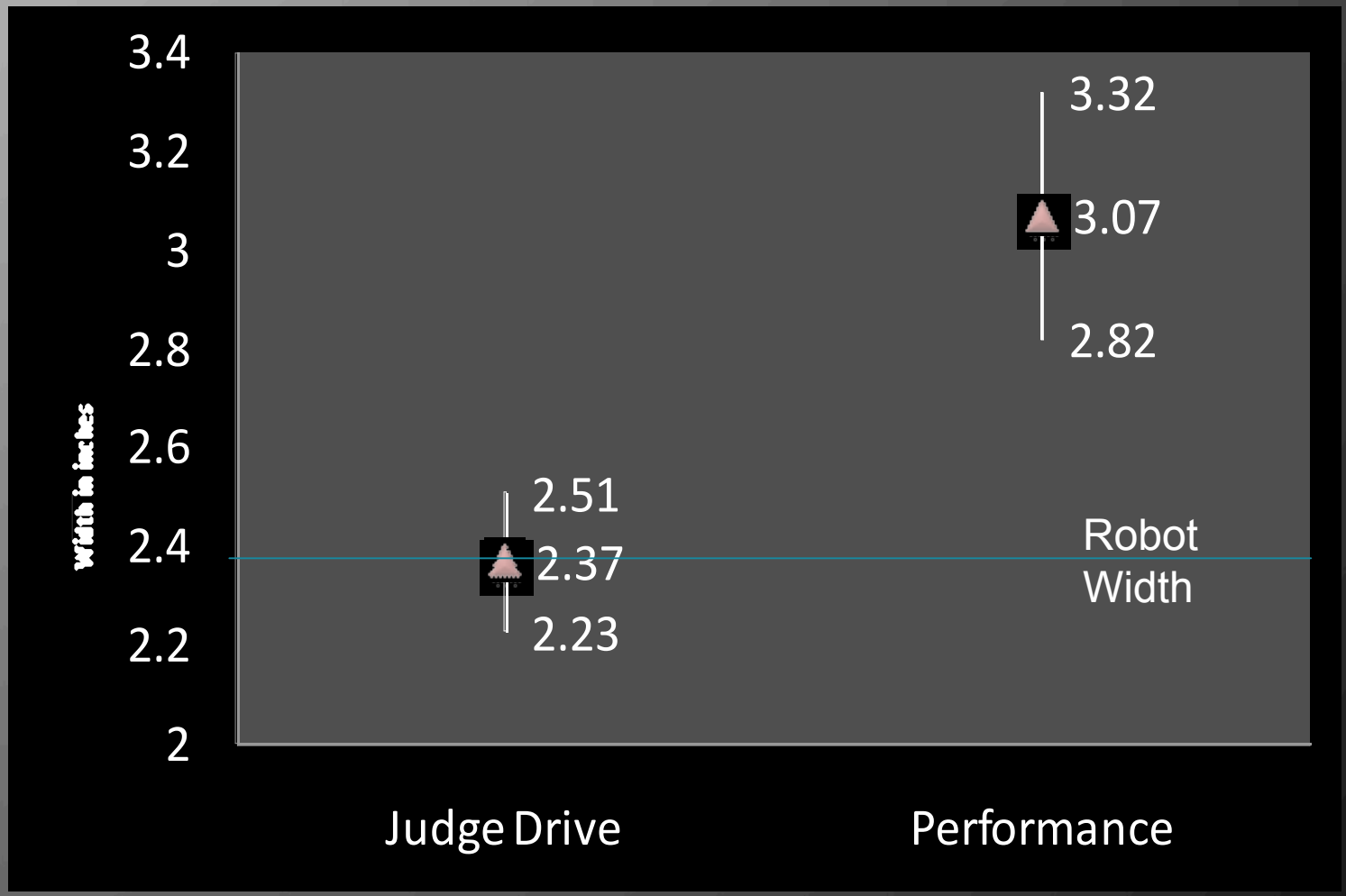
Results

- Converted raw data to threshold using averaged z-score method
  - chosen because the intervals between aperture widths were not equal, and the number of aperture widths was even (Woodworth & Schlosberg, 1954)
- Each participant got two thresholds, one for judgment and one for performance

Pass-ability



Drive-ability



Conclusions

- Present study replicated the findings of Jones and Johnson (2008)
- Data suggest that drive-ability judgments may not share the same accuracy that pass-ability judgments do

Extensions

- May be able to use pass-ability judgments to improve drive-ability judgments
  - Instruct operators that drive-ability requires a safety margin around pass-ability
  - Individualize this margin

Extensions

- May assist drive-ability by improving interface to provide more feedback
  - Display how accurately the operator controls the robot
    - By tracking variability in movement

References

- Burke, J.L., Murphy, R.R., Rogers, E., Lumelsky, V.J. & Scholtz, J. (2004). Final report for the DARPA/NSF interdisciplinary study on human-robot interaction. *IEEE transactions on Systems Man and Cybernetics Part C-Applications and Reviews,* 34(2), 103-112

- Casper, J. (2002). Human-Robot interactions during the robot-assisted urban search and rescue response at the World Trade Center. Masters Thesis, Department of Computer Science & Engineering, University of South Florida

- Jones, K.S., & Johnson, B.R. (2008). Why do tele-operated robots get stuck? *Paper presented at the Texas Regional Human Factors and Ergonomics One Day Conference,* Austion, Tx

- Moore, K.S., Gomer, J.A., Bulter, S.N., & Pagano, C.C. (2007) Perception of robot passability and aperture width during direct line of sight and teleoperation conditions. *Proceedings of the HFES 51st annual meeting,* pp. 1076-1080

- Moore, K.S., & Pagano, C.C. (2006). Can humans percieve affordances for teleoperated robots? *Poster presented at the North American Meeting of the International Society for Ecological Psychology,* Cincinnati, OH, (June 22-24), 2006.

Woodworth, R.S., & Schlosberg, H. (1954). *Experimental Psychology*, New York: Holt.