

# Open-road studies of pedestrian conspicuity at night: The robustness of biological motion configurations



**STACY BALK, RICK TYRRELL,  
& JUSTIN GRAVING  
CLEMSON UNIVERSITY**

# The Problem

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- ▶ Globally: 1.2 million road fatalities each year
  - ▶ 9<sup>th</sup> leading contributor to years of life lost
  - ▶ In developing countries, most fatalities are pedestrians
- ▶ By 2020:
  - ▶ Traffic fatalities are expected to become 3<sup>rd</sup> leading contributor to years of life lost
  - ▶ Over **1 million** pedestrian fatalities per year

World Health Organization, 2004

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# The Problem

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- ▶ In the US:
  - ▶ Over 4500 pedestrians are killed each year (NHTSA, 2004)
- ▶ Despite a reduction in pedestrian AND vehicle traffic at night (National Safety Council)
  - ▶ Over **half** of all pedestrian fatalities occur at night! (NHTSA, 2004)



# The Problem

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What's going on?

- ▶ Pedestrian fatalities 3-7 times more likely in dark than in light conditions
- ▶ Poor visibility has often been cited as a key causal factor

(e.g. Owens & Sivak, 1996; Sullivan & Flannagan, 2002)



# If visibility is the problem – What can we do?

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- ▶ Reduce speed limits. . .
- ▶ Increase lighting. . .
- ▶ Build more sidewalks and pedestrian bridges. . .
- ▶ Night vision enhancement systems (NVES). . .
- ▶ Make pedestrians more conspicuous!



# Biological Motion & Nighttime Pedestrian Conspicuity

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- ▶ Take advantage of our perceptual sensitivity to Biological Motion (BioMotion)
  - ▶ Place retroreflective material on the major joints
- ▶ Pedestrians wearing BioMotion are consistently recognized at longer distances at night (e.g., Owens, Antonoff, & Francis, 1994; Luoma, Schumann & Traube, 1996; Wood, Tyrrell & Carberry, 2005; Tyrrell et al., 2009)

But . . .



# What influences the conspicuity advantage of BioMotion?

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- ▶ Are all 11 markings necessary?
- ▶ Is actual motion critical?
- ▶ Is the orientation of the pedestrian important?
- ▶ How does a commercially available ANSI-approved vest compare to BioMotion?
- ▶ Can adding ankle markings to a vest increase conspicuity?
- ▶ How do visual distractions effect pedestrian conspicuity?



# On-Road Study 1

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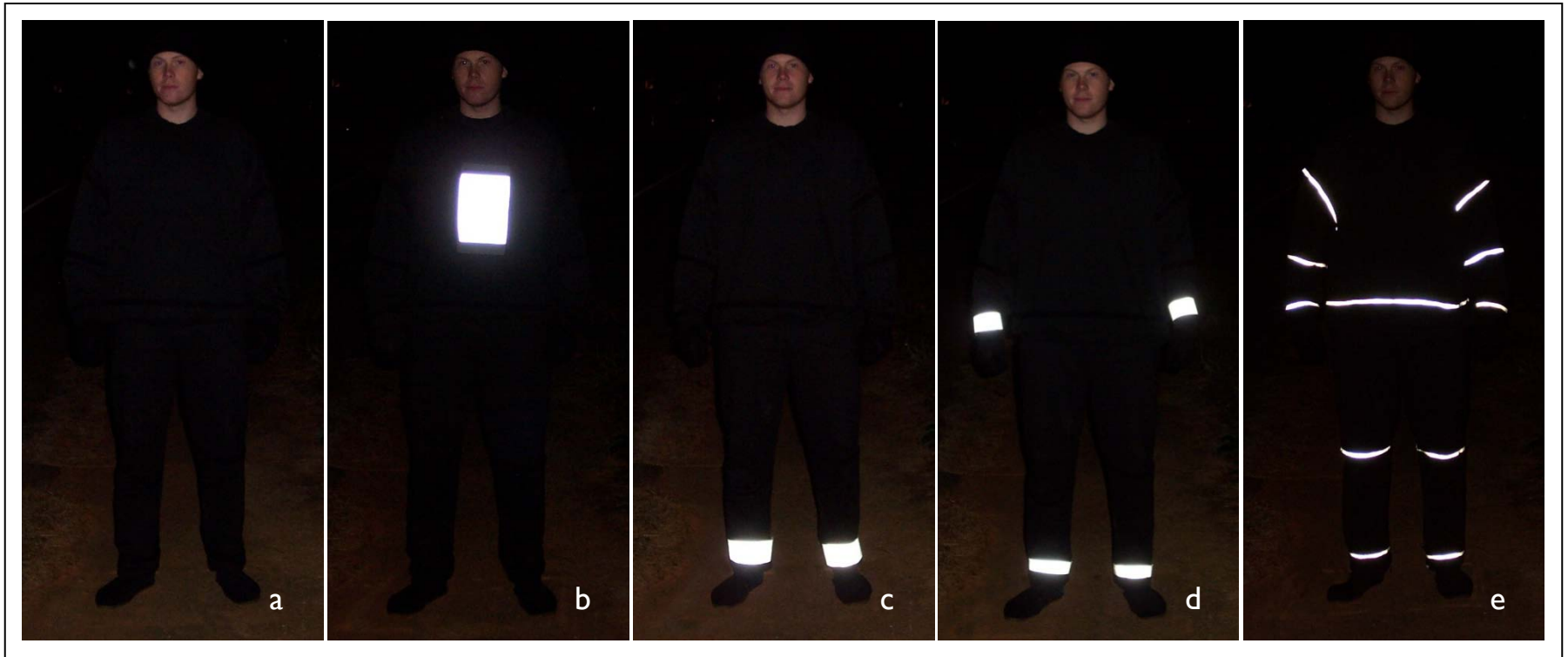
- ▶ Explored advantages of BioMotion:
  - ▶ With and without actual pedestrian **MOTION**
  - ▶ Clothing with fewer markings

Balk, Tyrrell, Brooks, & Carpenter, 2008

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Note: total surface area of exposed retroreflective material kept constant in b-e ( $302 \text{ cm}^2$ )

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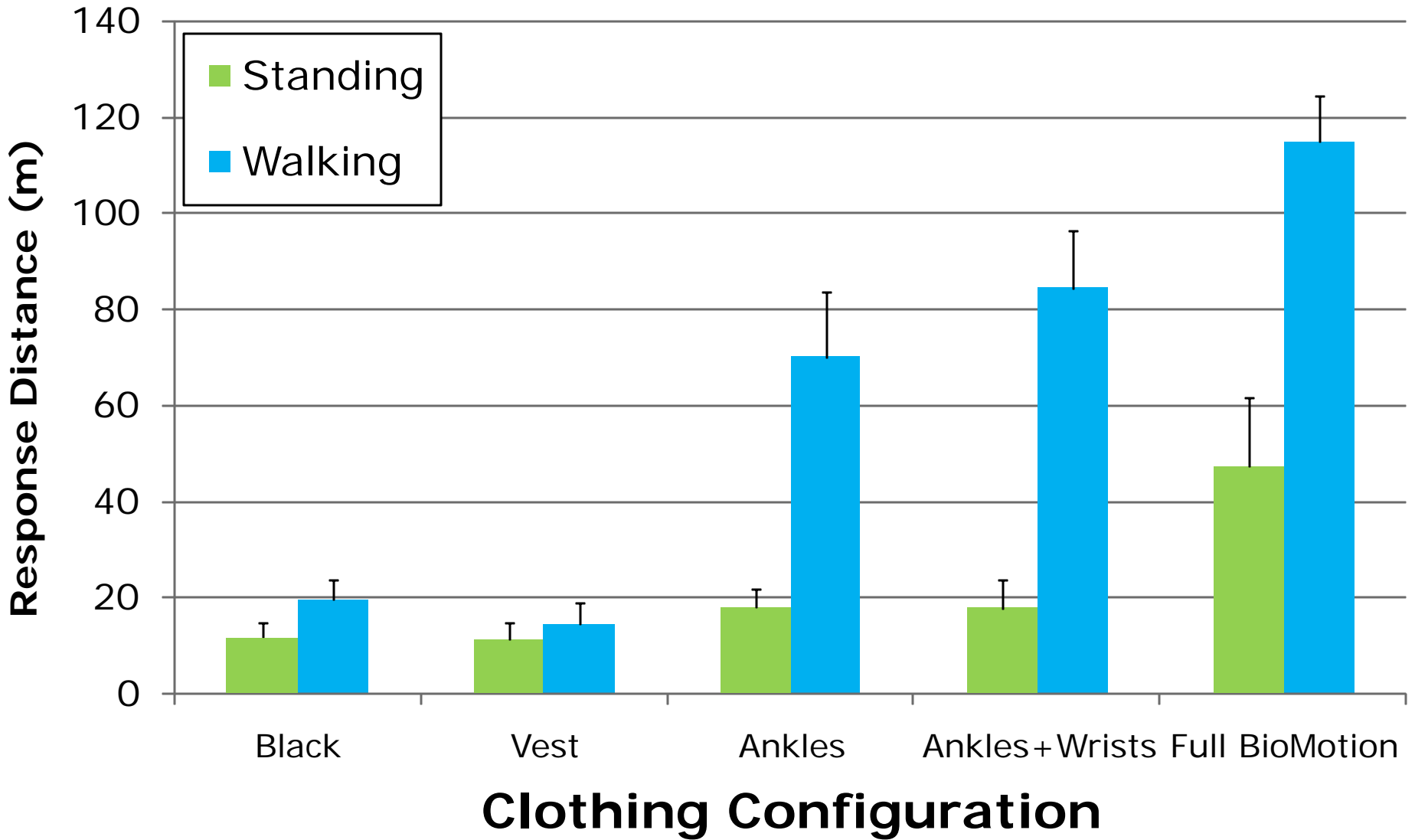


# Methods

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- ▶ Between-subjects design
  - ▶ Only encountered 1 test pedestrian (i.e. no learning effects)
- ▶ Told to press button “when you are confident that a pedestrian is present”





# Study 1 - Findings

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- ▶ Full BioMotion maximizes conspicuity

But

- ▶ There is a BioMotion advantage even without all 11 elements
  - ▶ Conspicuity quite high even when only the ankles & wrists are marked (especially when walking)
- ▶ Pedestrian motion critically important
  - ▶ But motion perception doesn't explain it all! There is still a "biological motion" benefit even when standing still



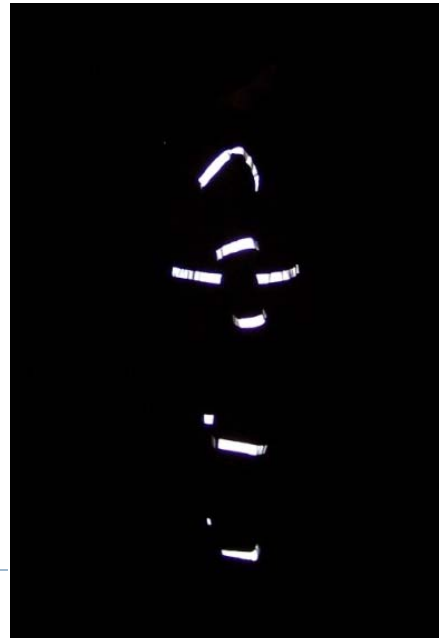
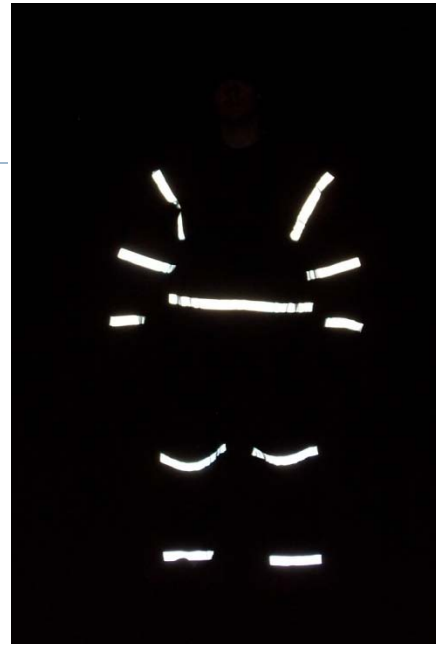
## On-Road Study 2

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- ▶ Test a commercially available vest (ANSI-approved)
- ▶ Test benefits of adding ankle markings to vest
- ▶ Test effects of pedestrian orientation



# ANSI class II vest



# Methods

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- ▶ 120 participants
- ▶ Between-subjects design
  - ▶ Only encountered 1 test pedestrian (i.e. no learning effects)
- ▶ Told to press button “when you are confident that a pedestrian is present”









# Findings

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- ▶ ANSI-certified vest does not maximize conspicuity
  - ▶ But adding ankle markings to ANSI vest results in substantial improvement (incorporates biomotion)
    - ▶ This configuration is both convenient and conspicuous
- ▶ Pedestrian orientation matters
  - ▶ Pedestrians facing the vehicle are more conspicuous
- ▶ Pedestrian motion matters too...
  - ▶ ...especially for pedestrians facing the roadway



# On-Road Study 2 – Part b

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- ▶ Test a commercially available vest (ANSI-approved)
- ▶ Test benefits of adding ankle markings to vest
- ▶ Test effects of visual distractions
  - ▶ Pedestrians often encountered near distracting visual events
    - ▶ e.g. suburbia, emergency situations, multiple groups of pedestrians



# Visual Distraction

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- ▶ 3 retroreflective triangles 50 ft apart, then...
- ▶ Vehicle with 4-way flashers, then...
- ▶ 3 retroreflective triangles 50 ft apart









# Findings

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- ▶ Visual distraction can delay detection...
  - ▶ ...but biomotion still maximizes conspicuity
- ▶ Stationary pedestrians are at particular risk when they are near visual distractions





# Advantages and Disadvantages

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- ▶ 2 key advantages of BioMotion
  - ▶ No expensive modifications to vehicles/roadways
  - ▶ Drivers are not required to monitor and interpret in-vehicle displays

BUT

- ▶ Requires pedestrians to take action



# Education

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- ▶ Pedestrians typically underestimate their own conspicuity especially when not wearing reflectors (Tyrrell, Wood, & Carberry, 2004)

SO

- ▶ Pedestrians may not be sufficiently motivated to utilize BioMotion

BUT

- ▶ Educational techniques have shown to reduce pedestrians' conspicuity overestimates (Tyrrell, Patton, & Brooks, 2004).



# Overall

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- ▶ The conspicuity advantages of BioMotion configurations are robust
  - ▶ Conspicuity advantages even when...
    - ▶ Facing the roadway
    - ▶ Standing still
    - ▶ Visual distraction present
    - ▶ Reduced retroreflectance
    - ▶ Visual clutter present (Tyrrell, et al., 2009)
    - ▶ Glare from opposing headlights present (Wood et al., minutes ago)
  - ▶ Adding reflective ankle straps to traditional vests may be best next step
    - ▶ Needs to be tested with “professional pedestrians”
- ▶ BioMotion + Education
  - ▶ Cost effective
  - ▶ Could be implemented in developed and developing countries



# Thanks!

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