


# Determining and Strengthening the Visual Cues for Predicting Cyclist Intent in Traffic

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# PROJECT OVERVIEW

- Externally funded project: 
  - Urbanist I and II (1.9 msek) (~2011-2014)
- General project goal:
  - To identify the signals and/or combination of signals that a driver could use to successfully (or unsuccessfully) attend to cyclists and to predict their intentions in traffic.

# PROJECT OVERVIEW

- Vision and biological motion perception
  - Innate sensitivity to human movement
  - Biomotion clothing -> better detection (Wood et al., 2009)
- "Social" signals for predicting cyclist intention
  - Eye contact
  - Head movement
  - Pedaling
  - Speed
  - Position in bike lane



# PROJECT OVERVIEW

- **Specific questions:**

1. How accurate are people at determining the intentions of cyclists near a bicycle crossing? Will they turn or go straight?
2. If accuracy is better than 50/50, what signals are used to predict behavior?
3. At what distance from the crossing do the most critical signals arise?
4. What is the accuracy of a model based on the signals from question 2?



# PROJECT OVERVIEW

## Four experiments:

- Signal identification
- When do signals occur?
- Signal verification
- Improve signal detection



# SIGNAL IDENTIFICATION

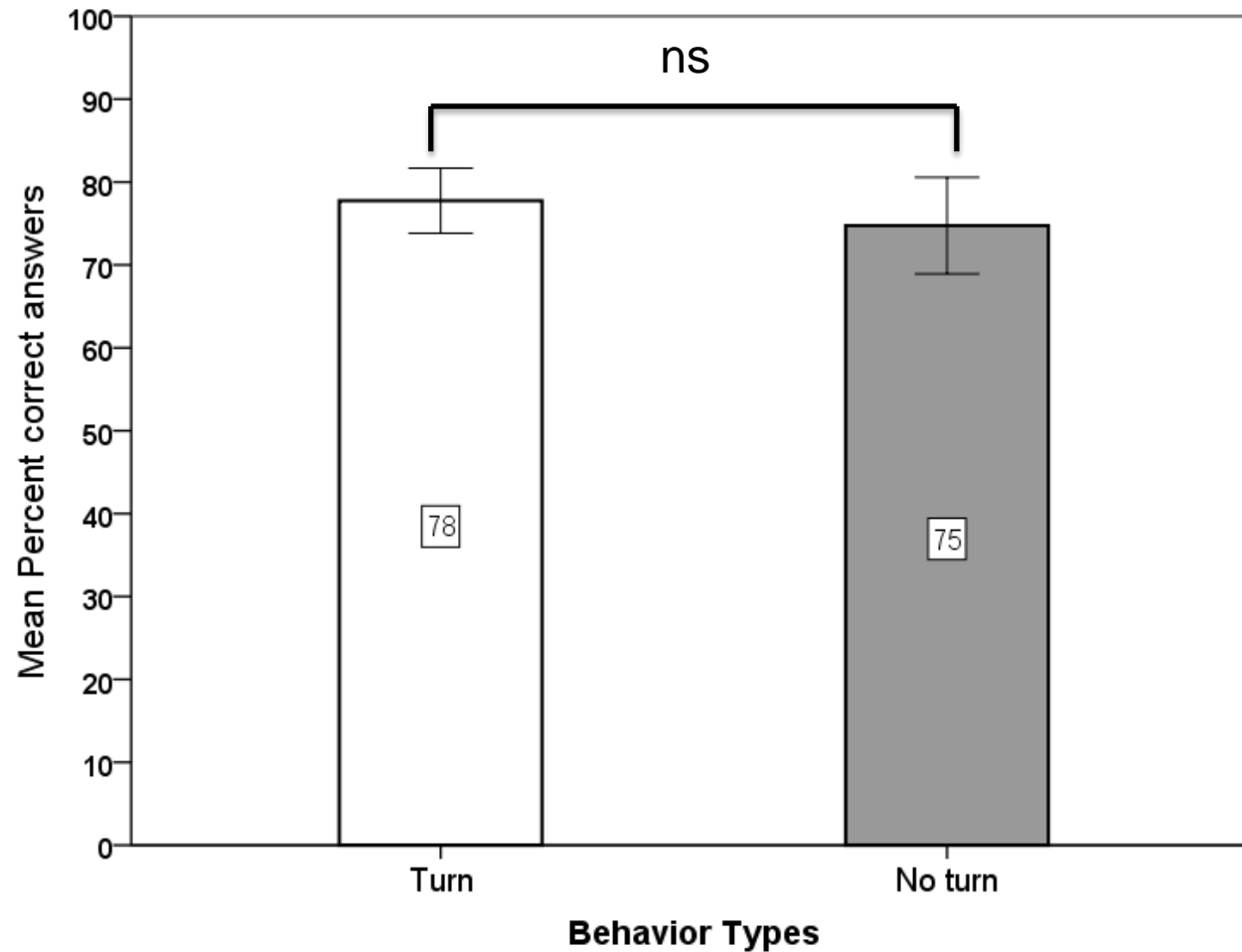
## GO/NoGo

- 20 participants (in groups)
- 40 video sequences
  - 20 Go & 20 NoGo sekvenser, random order
  - Clip 6m before crossing
  - Response interval: 20 s, sound indicates next sequence
- Task:
  - 1: Will the cyclist cross?
  - 2: What cues are you using?

# CROSSWALK



# RESULTS

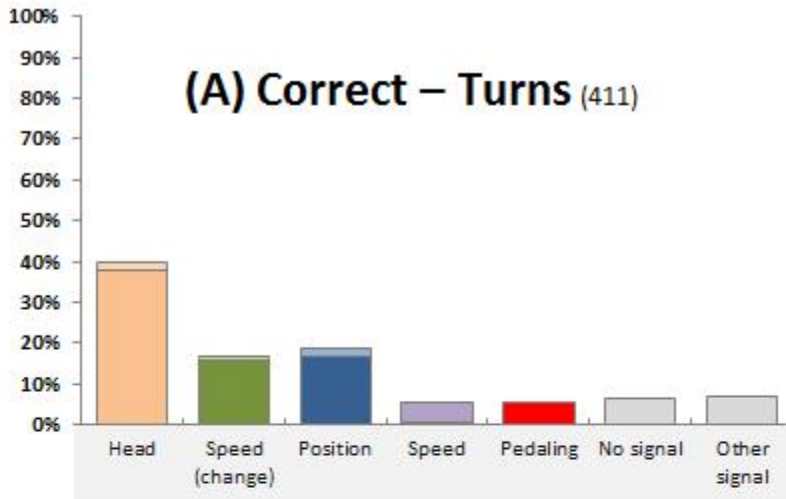


Error Bars:  $\pm 2$ . SE

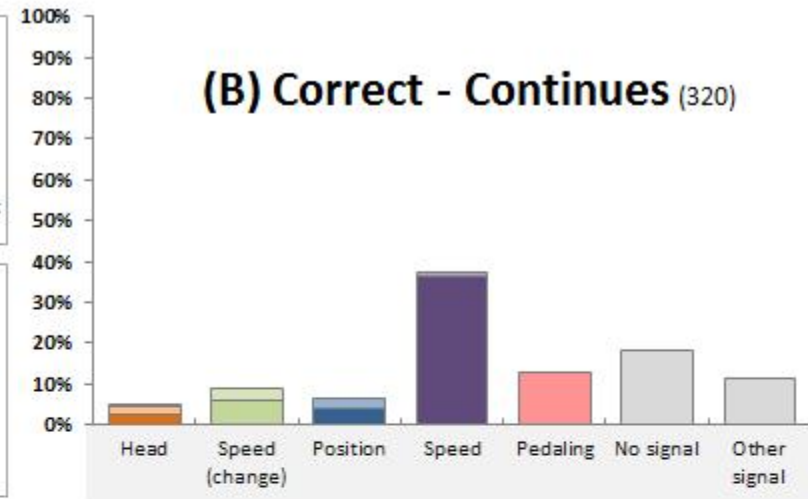


# RESULTS

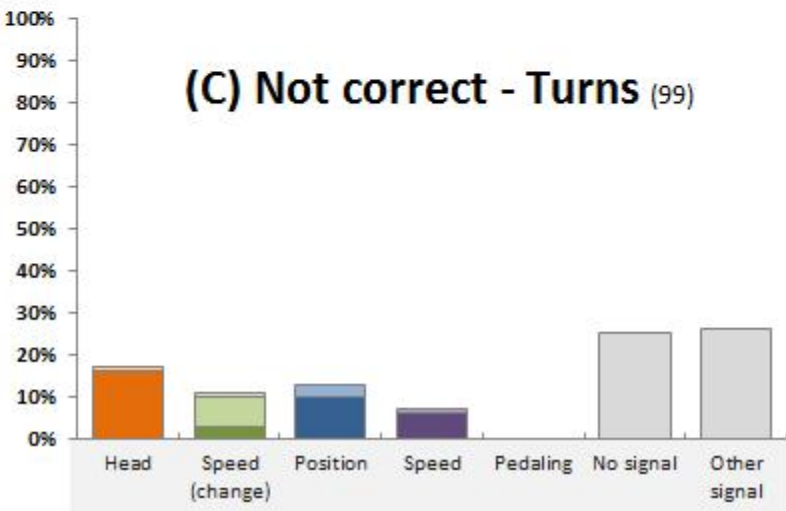
**(A) Correct – Turns (411)**



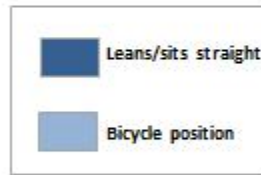
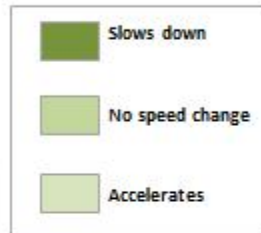
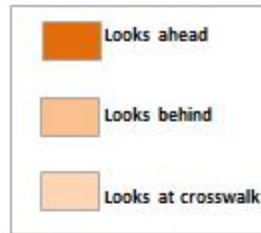
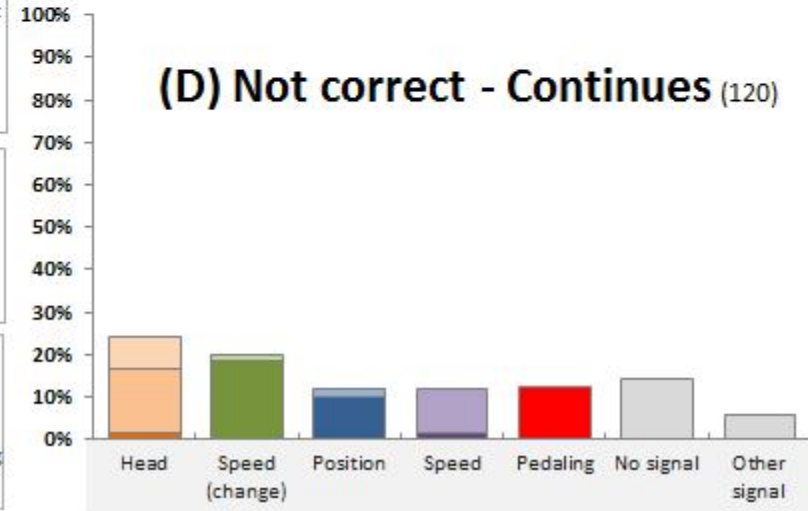
**(B) Correct - Continues (320)**



**(C) Not correct - Turns (99)**



**(D) Not correct - Continues (120)**



# WHEN DO SIGNALS OCCUR?

## Additional crossing:

- Similar to previous, no crossing signal
- 40 sequences (20 Go och 20 NoGo)
  - 28 hours of recorded material



# WHEN DO SIGNALS OCCUR?

Two different distances:

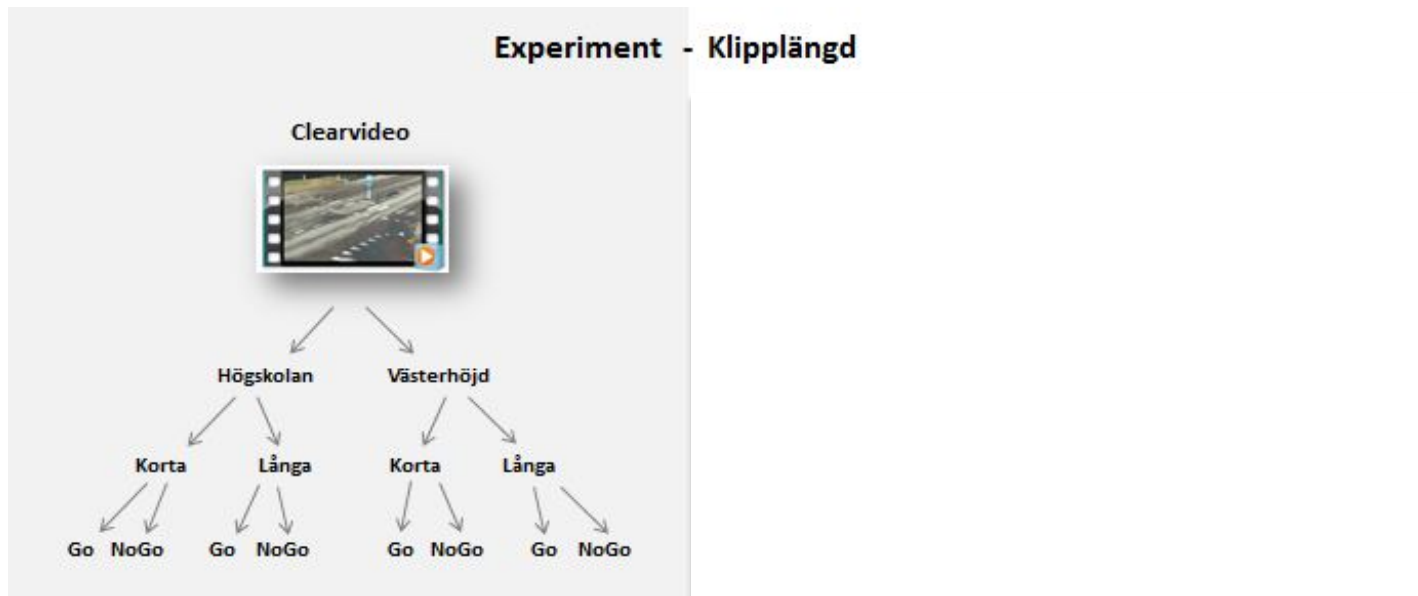
- 9 and 3.5 meters from the crossing



# WHEN DO SIGNALS OCCUR?

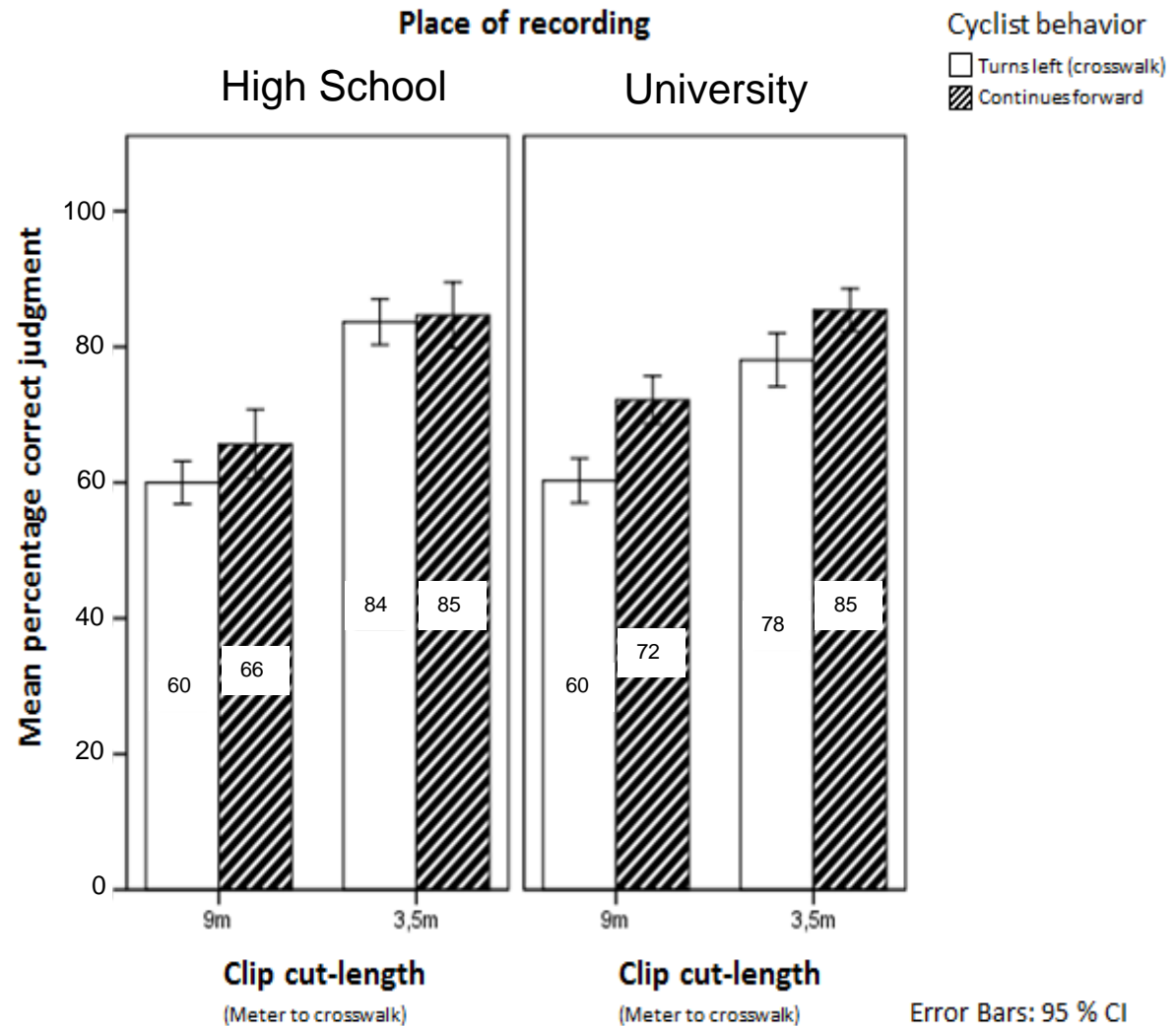
## Experiment design:

- 4 groups: 15 participants per group
- Judge 80 sequences
  - Cross? (yes-no) + confidence judgment (6 levels)



# WHEN DO SIGNALS OCCUR?

## Results:



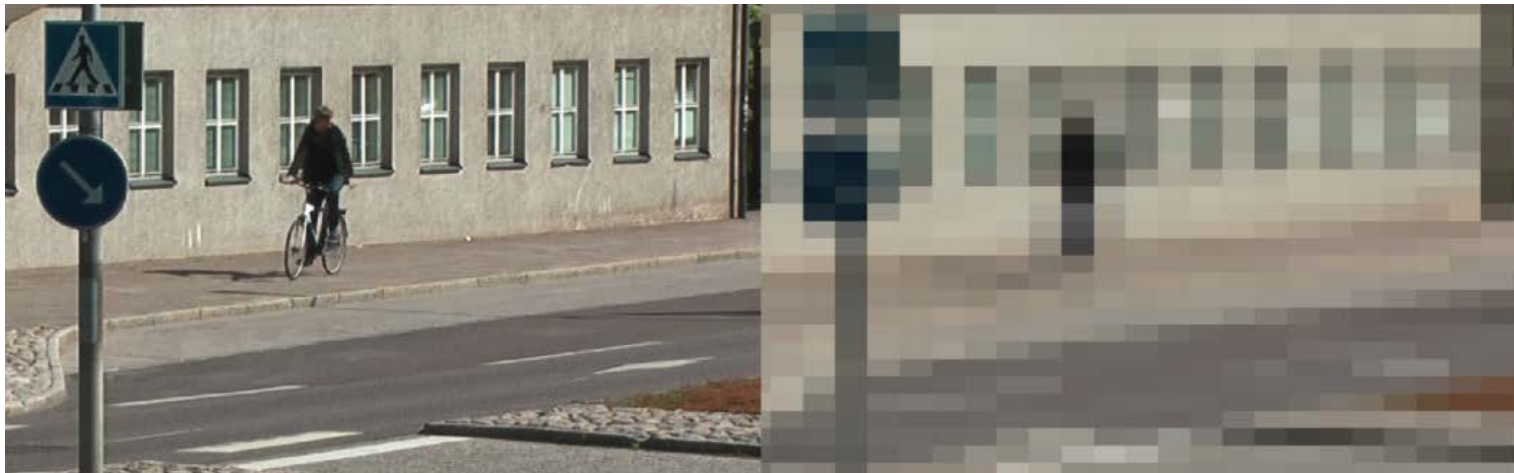


# SIGNAL VERIFICATION

Urbanist - iD 001

## Masking experiment:

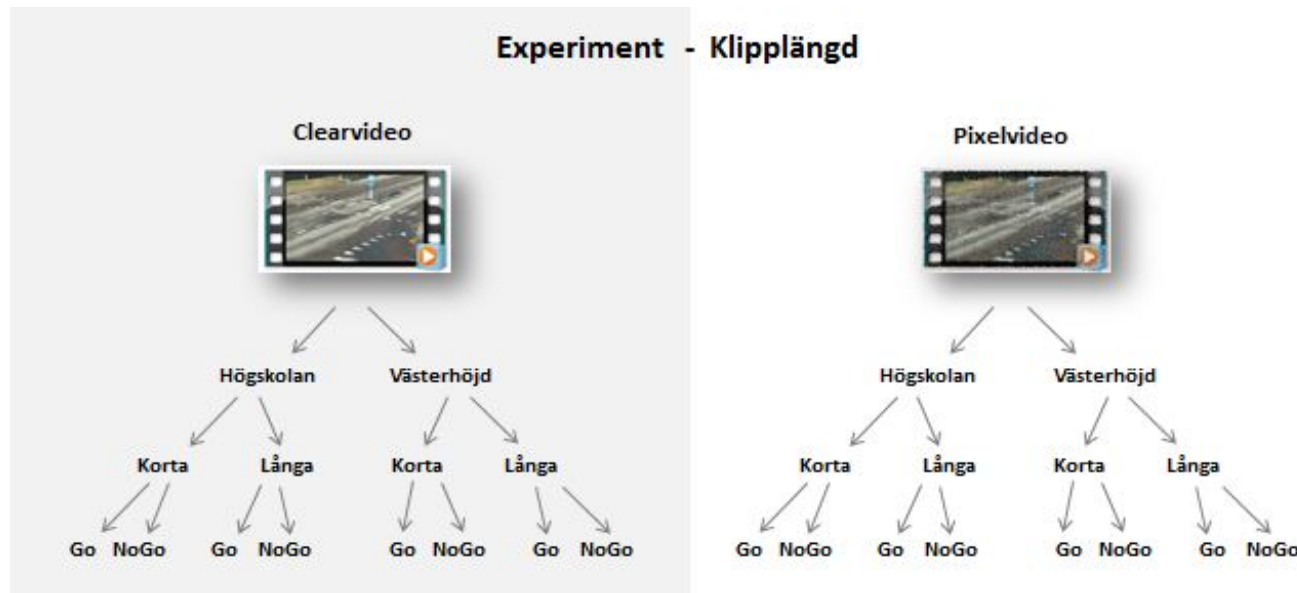
- Mask head movement and pedaling
- Retain signals: position and perceived speed
- Same sequences as earlier
  - Selective motion masking of sequences



# SIGNAL VERIFICATION

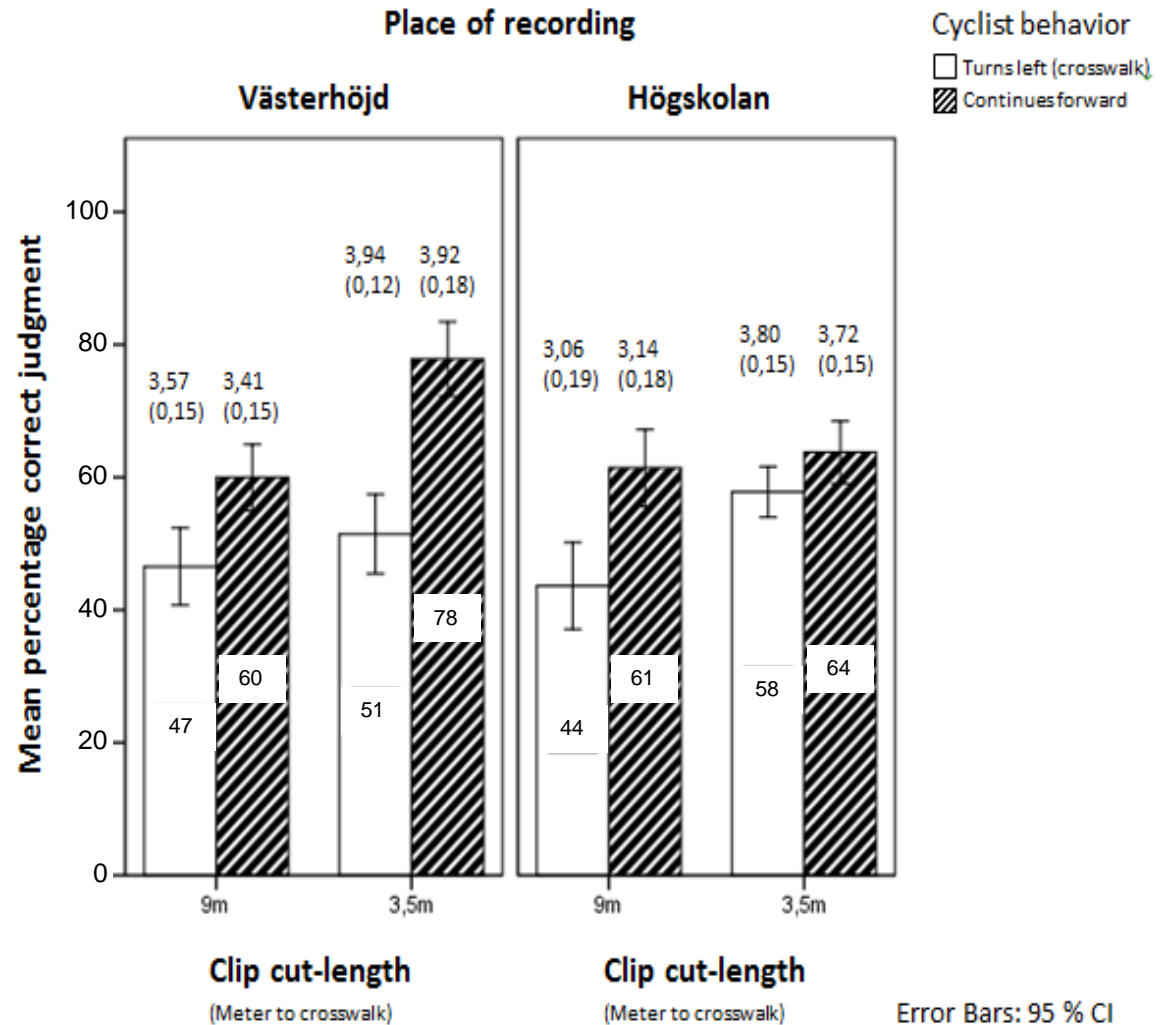
## Experiment design:

- 4 groups: 15 participants per group
- Judge 80 sequences
  - Cross? (yes-no) + confidence judgment (6 levels)



# SIGNAL VERIFICATION

## Results:





# LOGISTIC REGRESSION MODEL

- Determine predictive value of signals:
  - Independent annotation of signals

**Classification Table<sup>a</sup>**

Observed			Predicted		
			Cyclist behavior		Percentage Correct
			Go	NoGo	
Step 1	Cyclist behavior	Go	34	5	87,2
		NoGo	2	39	95,1
Overall Percentage					91,3

a. The cut valu

**Model Summary**

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	32,305 <sup>a</sup>	,625	,834

a. Estimation terminated at iteration number 7 because parameter estimates changed by less than ,001.

# LOGISTIC REGRESSION MODEL

- Weighting of signals:

**Variables in the Equation**

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1 <sup>a</sup>	Headturn	-1,907	,770	6,133	1	,013	,148
	Speed	1,876	,835	5,053	1	,025	6,528
	Speedchange	1,000	,659	2,305	1	,129	2,719
	Leaning	-,057	,537	,011	1	,916	,945
	Position	2,551	,799	10,193	1	,001	12,822
	Pedaling	,662	,823	,648	1	,421	1,939
	Constant	1,204	,946	1,620	1	,203	3,333

a. Variable(s) entered on step 1: Headturn, Speed, Speedchange, Leaning, Position, Pedaling.

# CONCLUSIONS

- Head movement and position are important!
  - When cyclist turns
  - In conjunction with a crossing:
    - Less than 9 meters
- Different signals for *crossing* behavior and for *straight* ahead.
  - Straight ahead: perceived speed and position

# URBANIST II

- Develop and study the effects of simple visual aids to:
  - a) strengthen/facilitate the reading of social signals and
  - b) to increase the visibility of cyclists at nighttime as well as during the daytime.
- Internet based experiment

# URBANIST II

- Different reflector configurations: material and placement
  - Legal
  - Vest
- Biomotion placement
  - Fluorescent material
  - Reflector material
  - Combination

# CLOTHING PATTERNS





# RECORDING CONDITIONS

Framifrån

Bakifrån

Dag



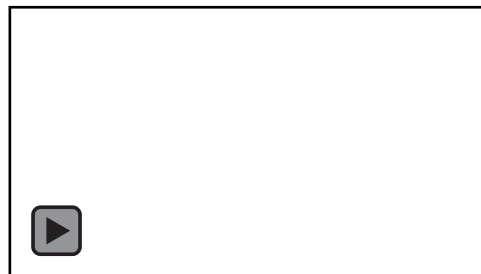
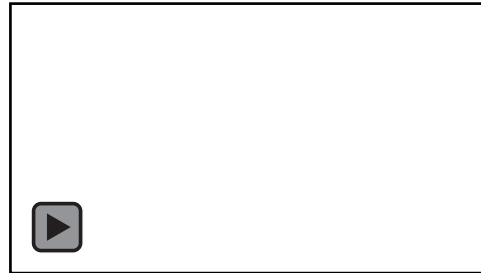
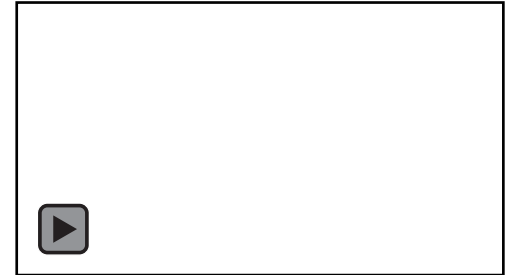
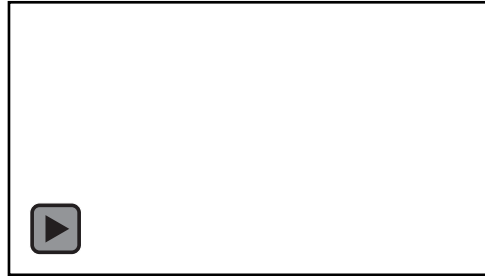
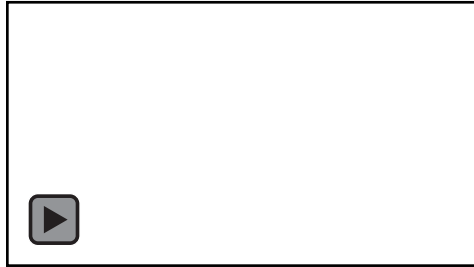
Skymning



Natt



# EXAMPLE SEQUENCES





# RESULTS

**Means in percent for correct judgments of cyclist intent for short durations (9 meters from crossing) according to legal, recommended and biomotion (reflector) clothing patterns.**

		Clothing Patterns		
		Legal	Recommended	Biomotion
Lighting	Day	76	92	95
	Dusk	66	77	87
	Night	62	70	92

# THANK YOU!

- Questions?

