



# SMARTPHONES AND ALWAYS-ON LOCATION DATA

Assessing the impact of a transition to mobile devices

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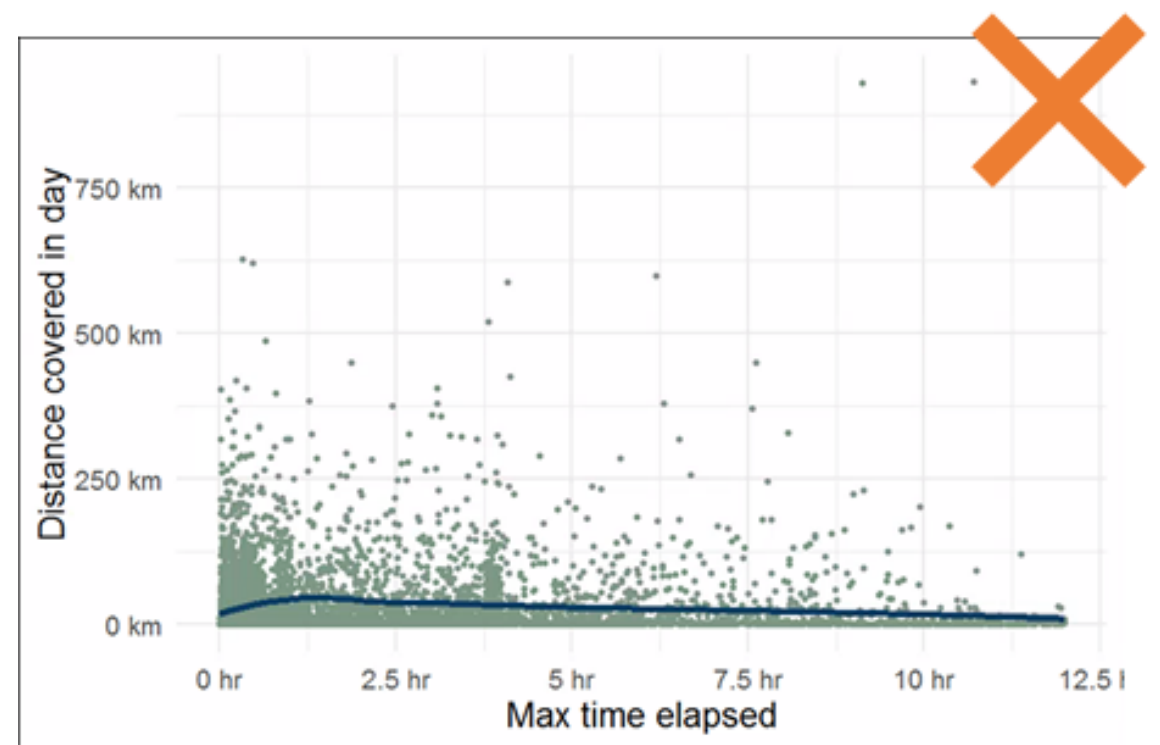
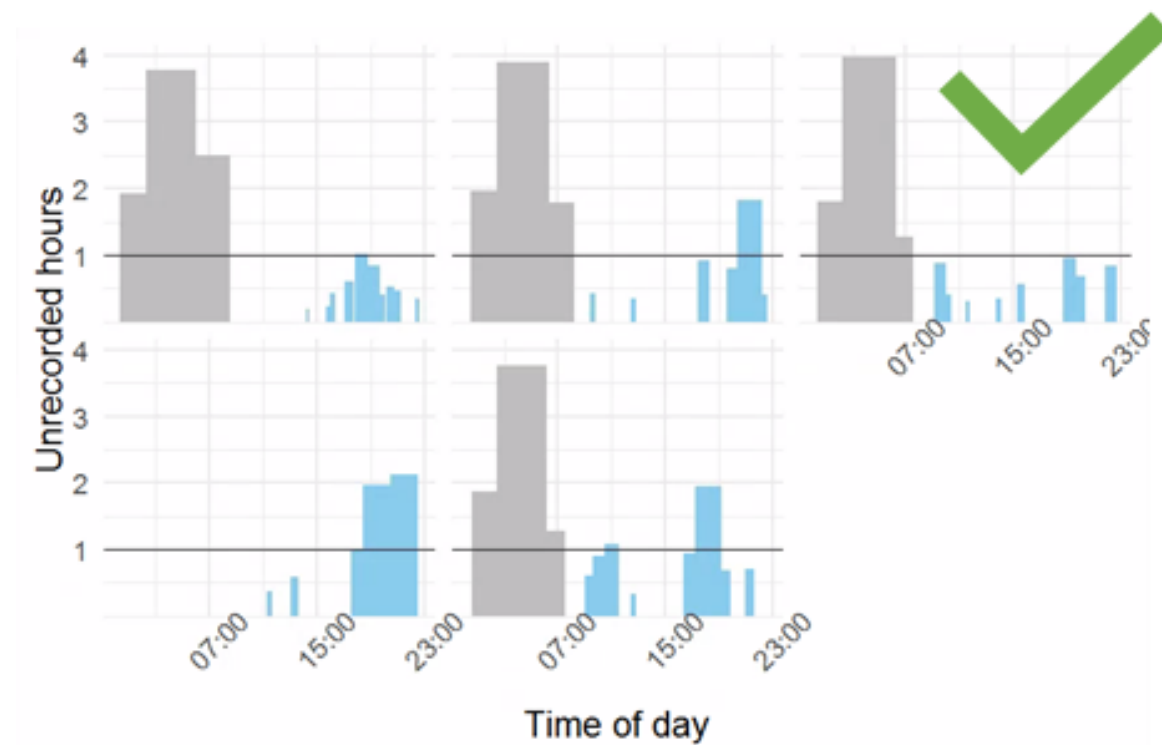
PETER LUGTIG

BARRY SCHOUTEN

REMKO SMIT

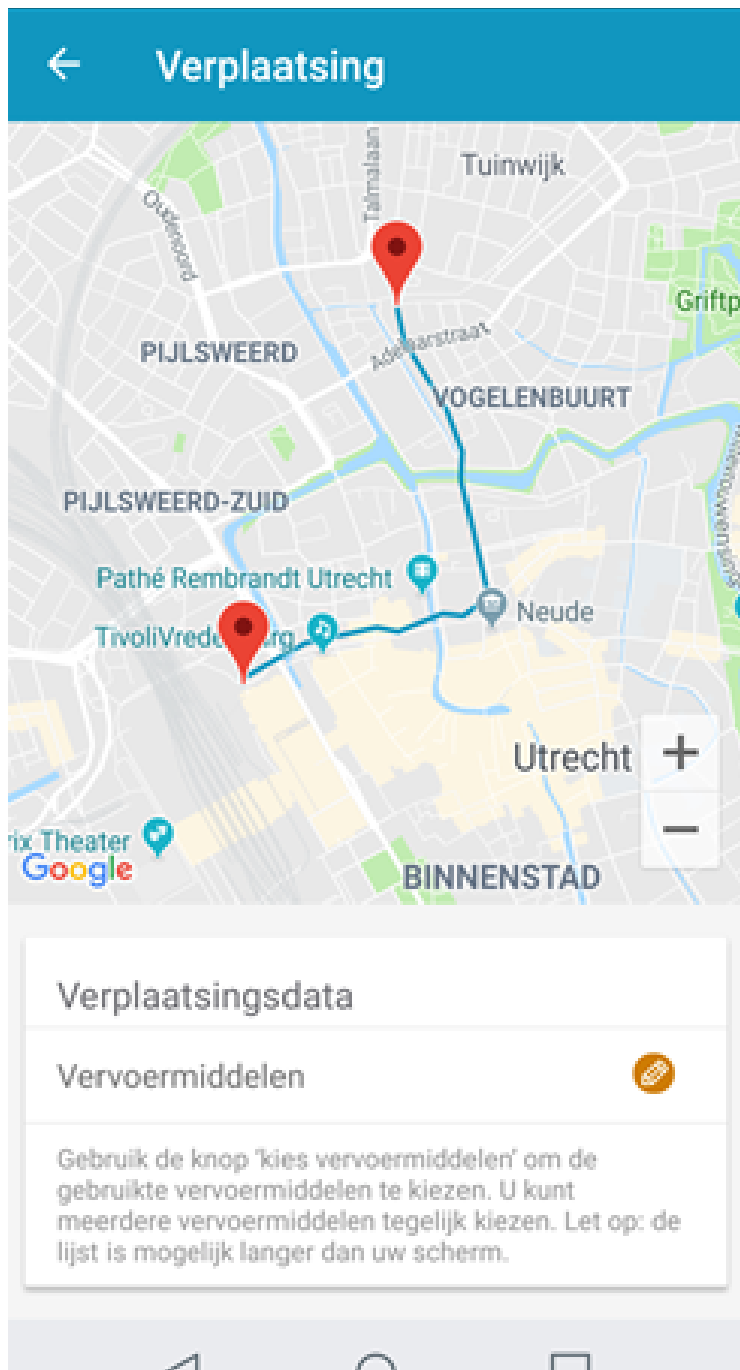
**50% MISSING DATA**

# IS IT OKAY?



SECTION 1

# CONTEXT



# THE TABI APP

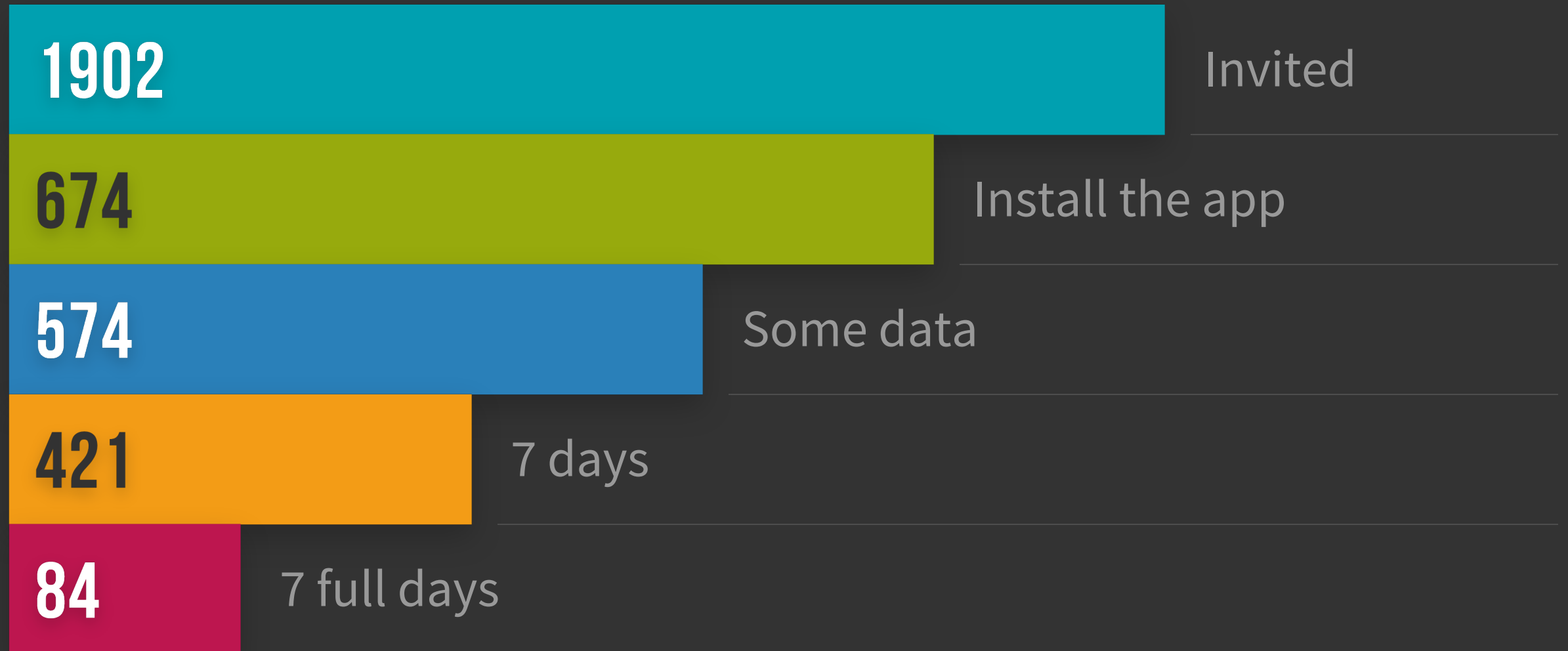
- **GOAL: PROVIDE TRACKING DATA FOR A MOBILITY SURVEY**

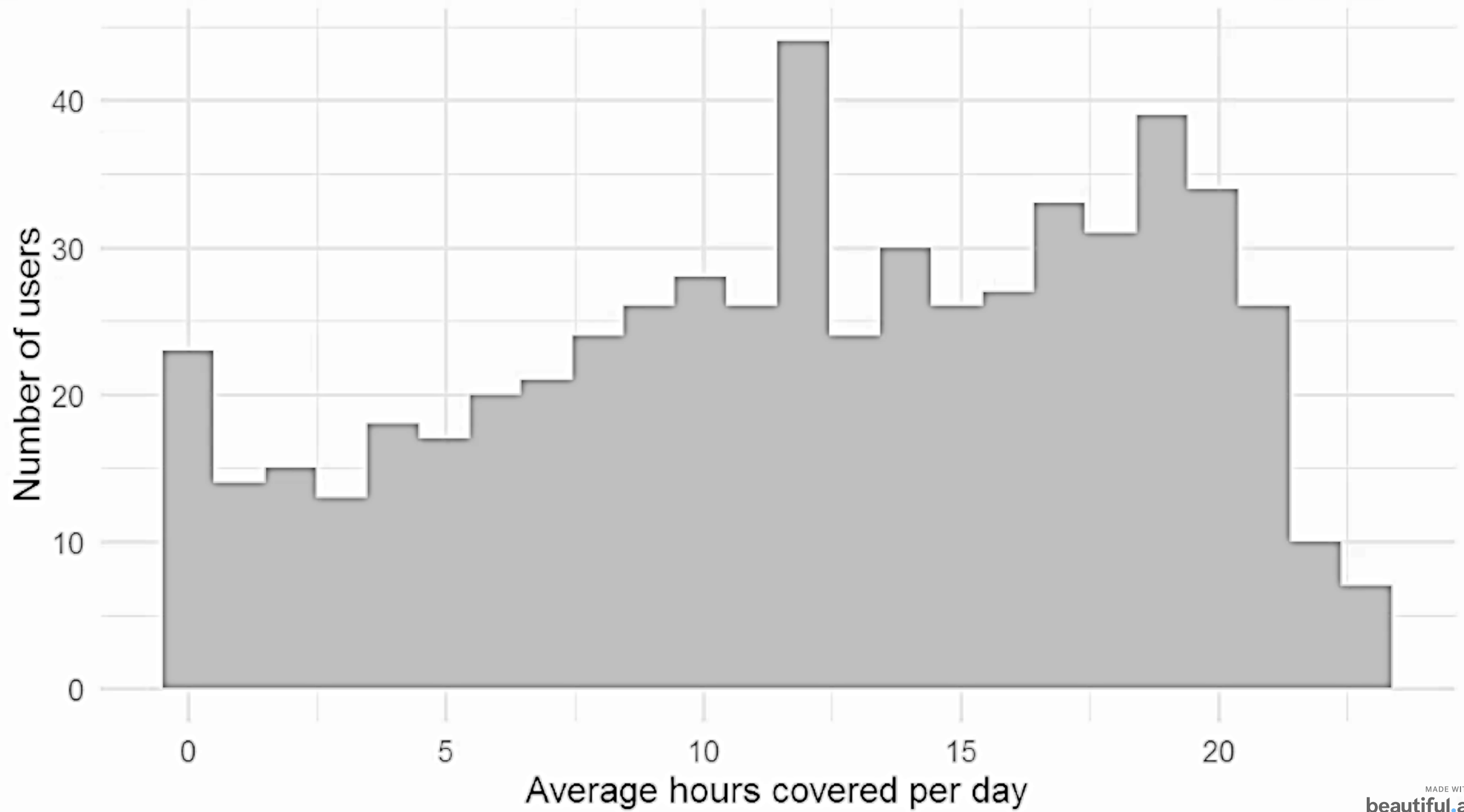
- **POTENTIAL BENEFITS**

No recall problems  
Lower burden  
Fine-grained data

- **PROBLEM: UNTESTED IN OFFICIAL STATISTICS**

# THE TABI FIELD TEST





## SECTION 2

# CAUSES OF MISSING LOCATION DATA



## BRAINSTORMING POTENTIAL CAUSES

- PHONE HIBERNATION
- APP INSTALLATION
- LOCATION PERMISSIONS NOT GIVEN
- DEVICE DIES
- PARTICIPANT LEAVES PHONE AT HOME
- APP CLOSES ITSELF
- SHORT LOSSES DUE TO TUNNELS OR BUILDINGS

## BRAINSTORMING POTENTIAL CAUSES

- **PHONE HIBERNATION**

- **APP INSTALLATION**

Device was registered

- **LOCATION PERMISSIONS NOT GIVEN**

'Never-datas'

- **DEVICE DIES**

Battery discharge tracked

- **PARTICIPANT LEAVES PHONE AT HOME**

We'd still receive data

- **APP CLOSES ITSELF**

- **SHORT LOSSES DUE TO TUNNELS OR BUILDINGS**

Bigger and badder than multipath errors

## BRAINSTORMING POTENTIAL CAUSES

- **PHONE  
HIBERNATION**
- **APP CLOSES  
ITSELF**

SECTION 3

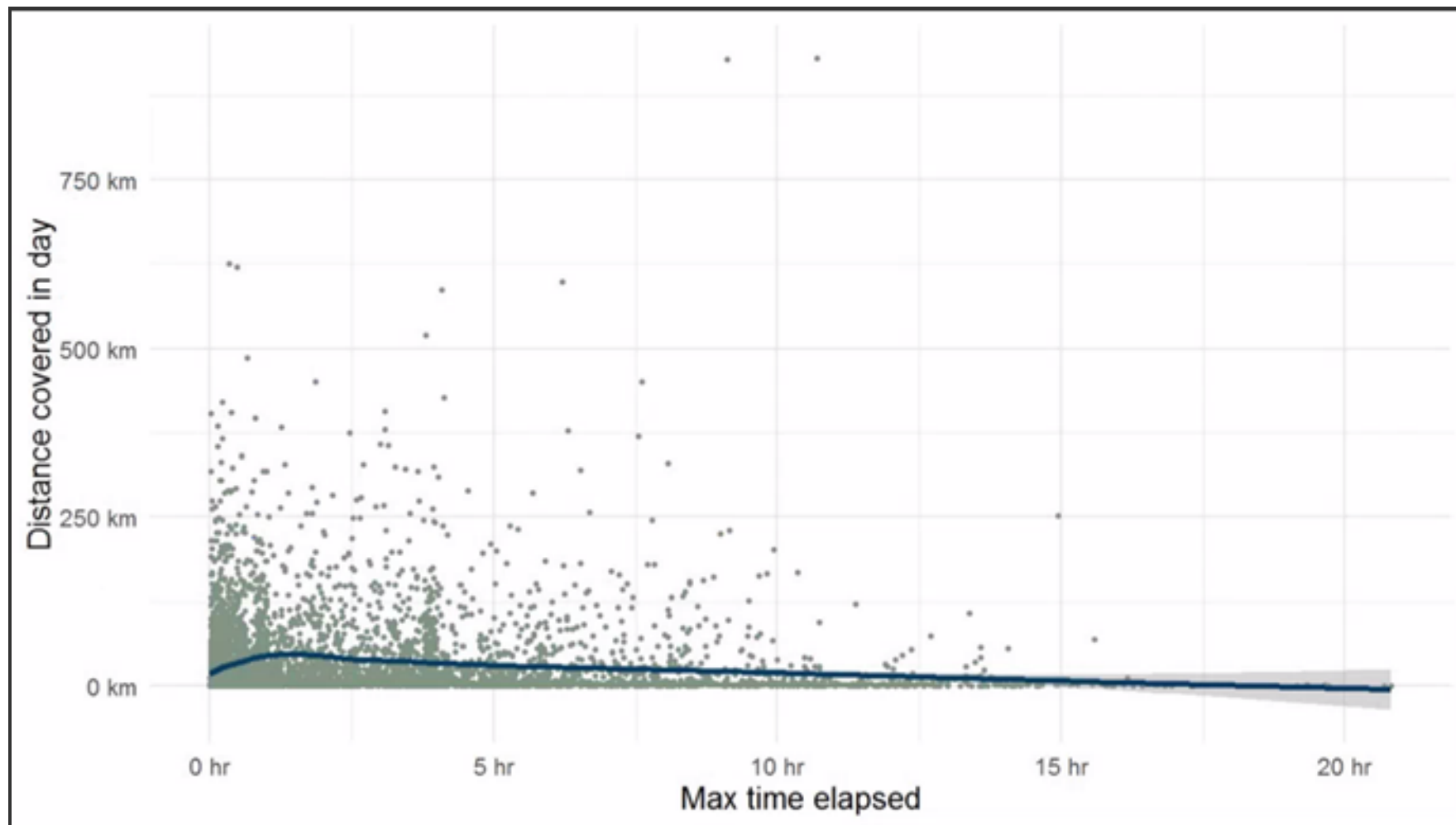
# RESULTS (SOME)

# GAP TIME

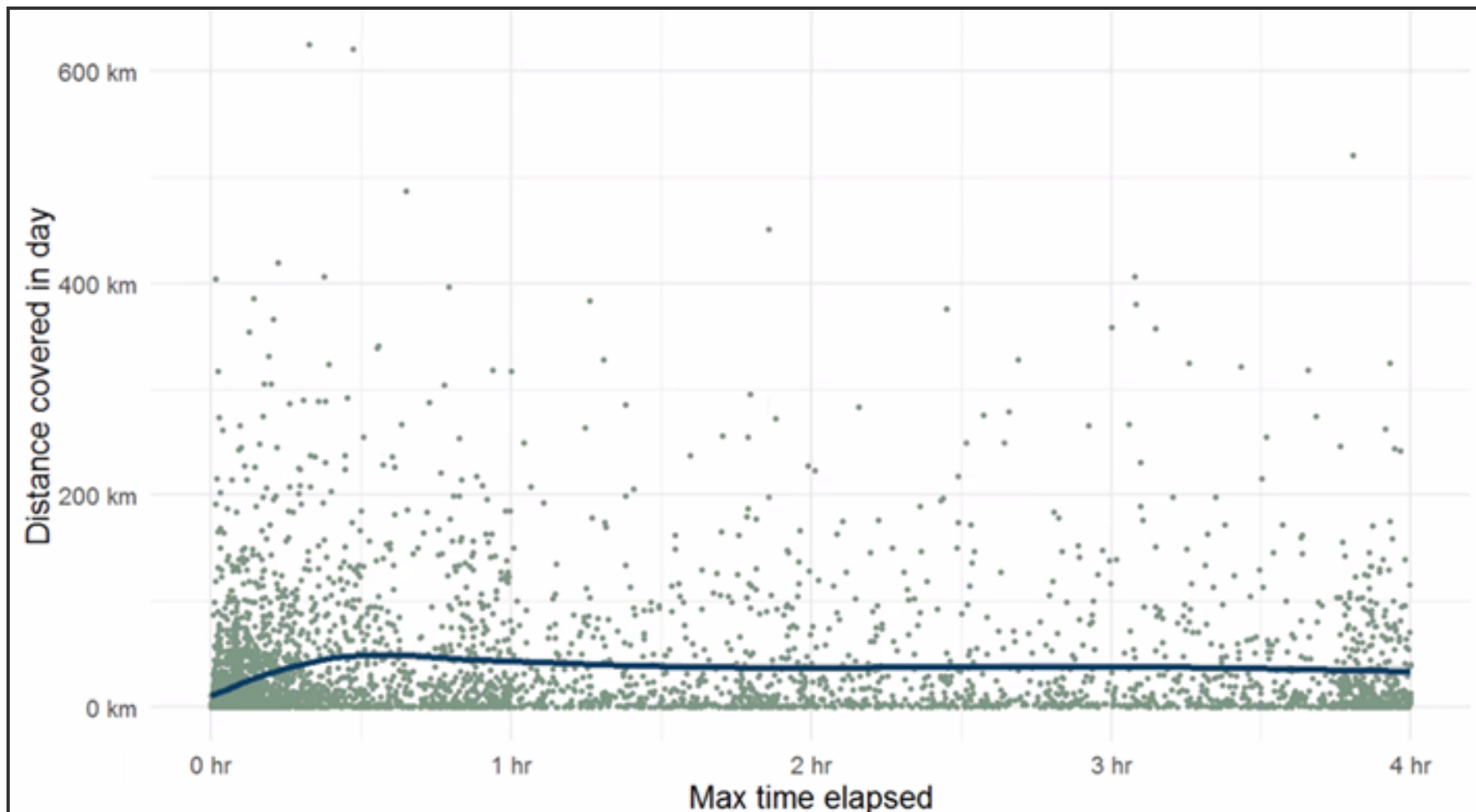
- TRACKING CONTINUOUS LOCATION
- IN A DISCRETE WAY
- WE RARELY GET A RESPONSE EACH SECOND FROM THE OS
- LENGTH OF TIME BETWEEN TWO REPORTED LOCATIONS IS GAP TIME
- MAXIMUM GAP TIME ON A GIVEN DAY FOR A GIVEN USER CAN BE USED AS A MISSINGNESS METRIC

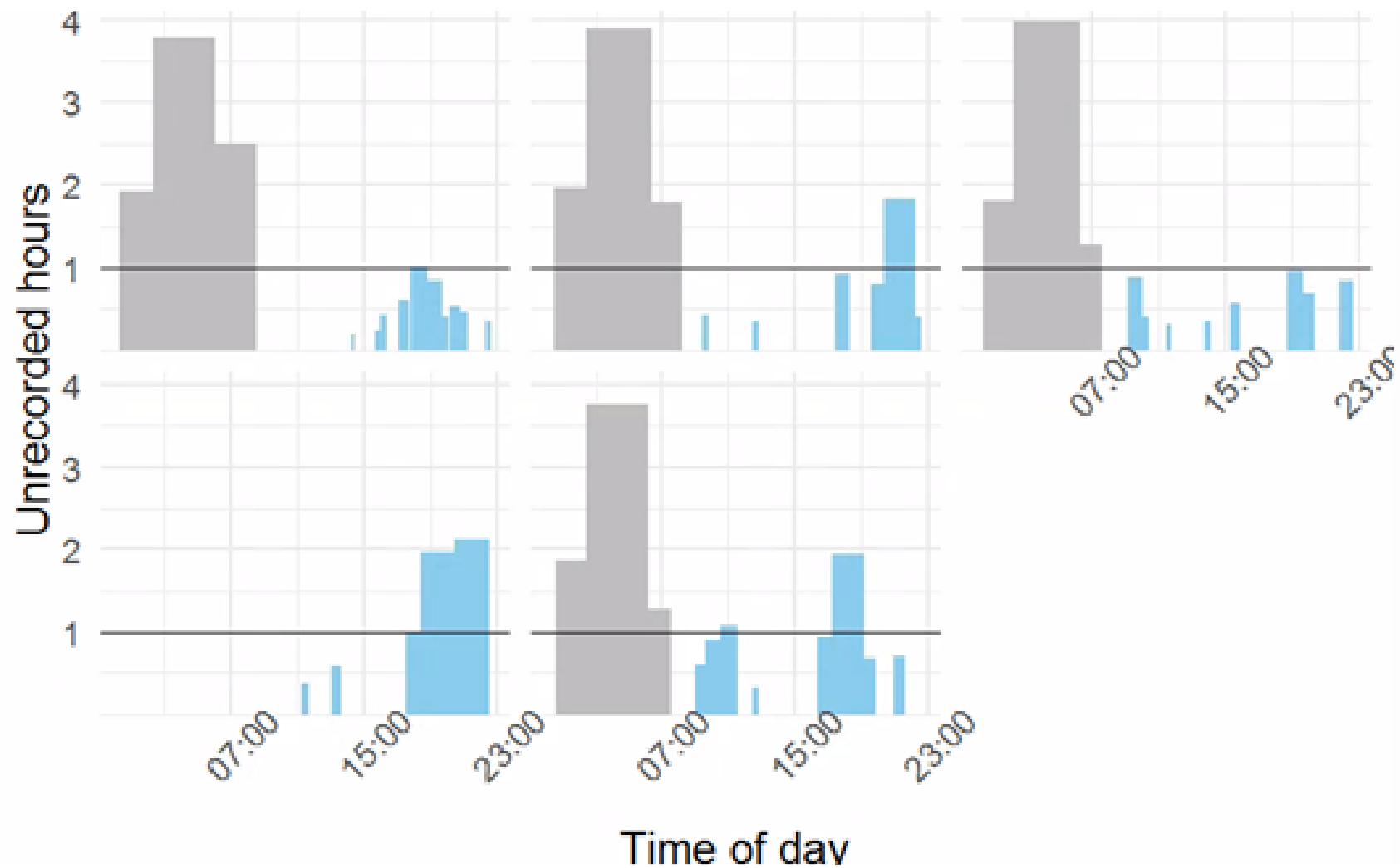


# GAP TIME ANALYSIS



# GAP TIME ANALYSIS

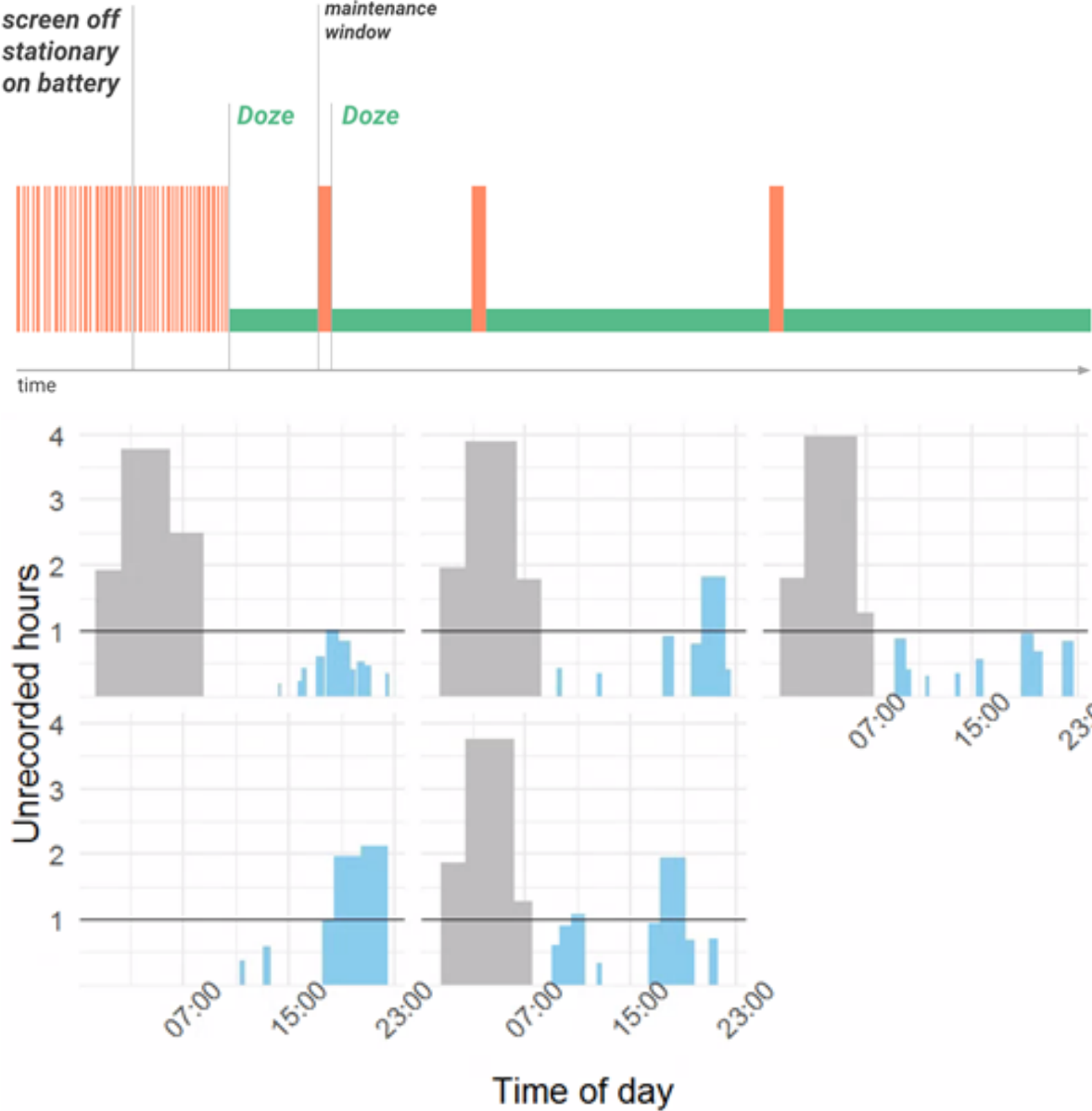


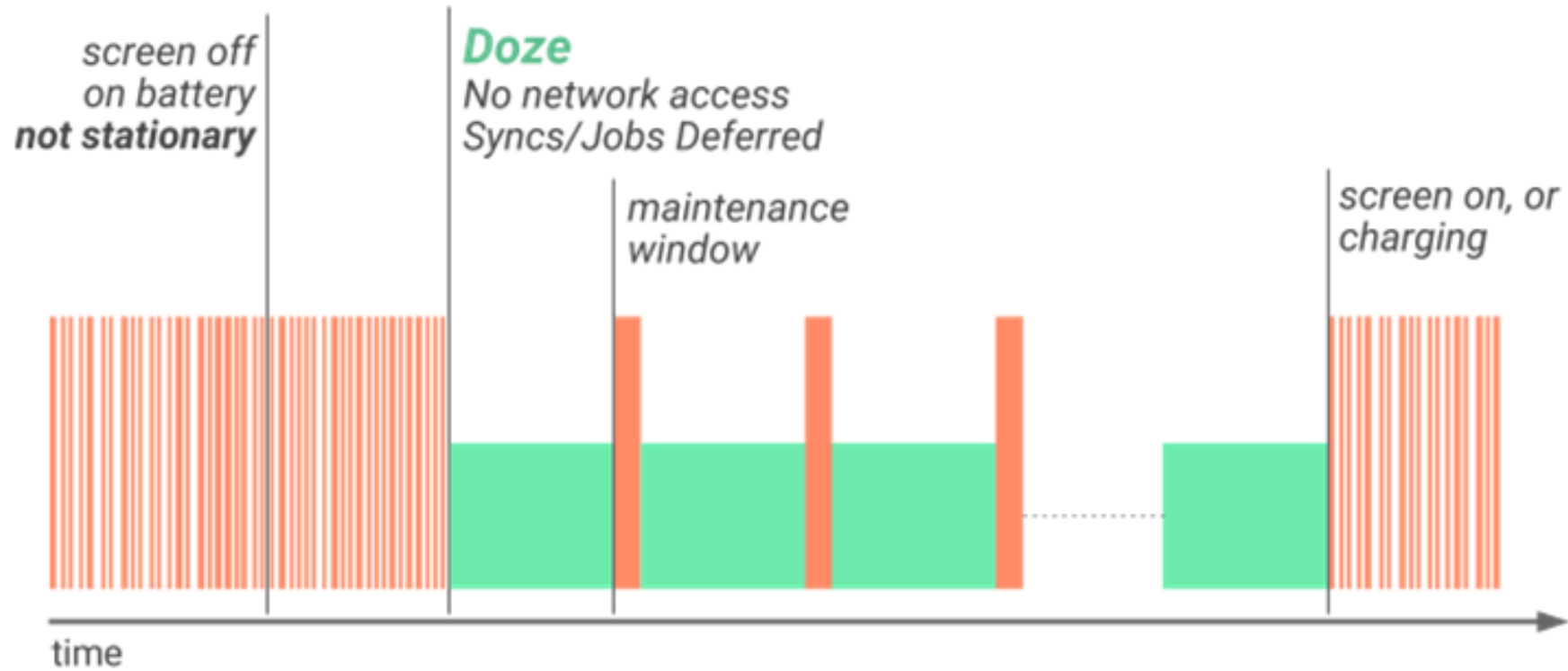


**MISSING DATA OVER TIME**

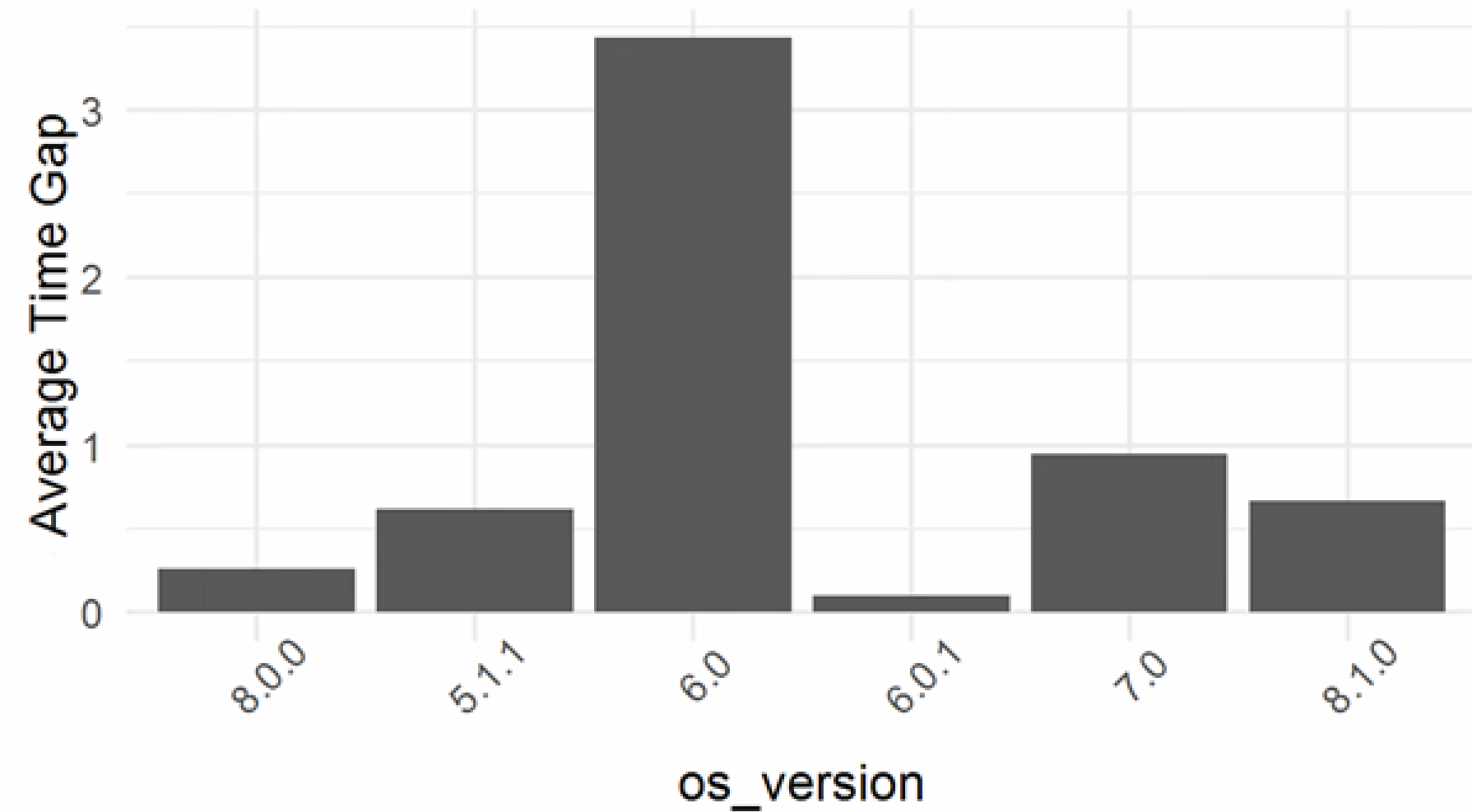


# “DOZE MODE”





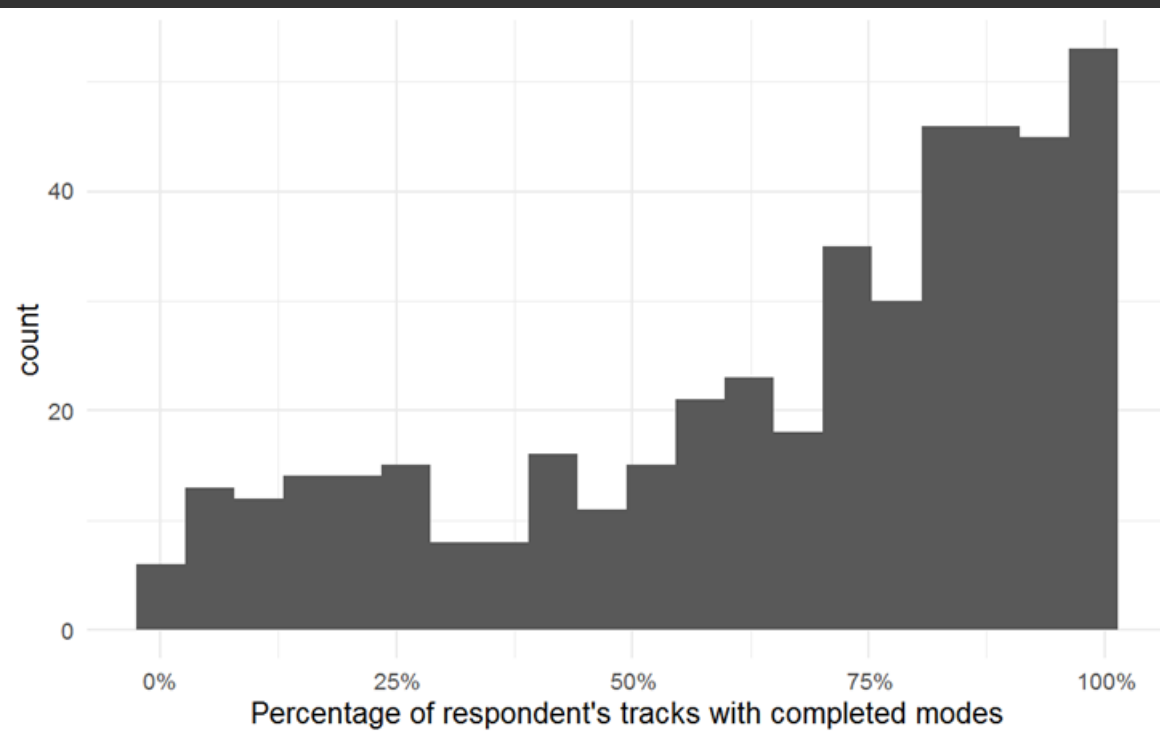
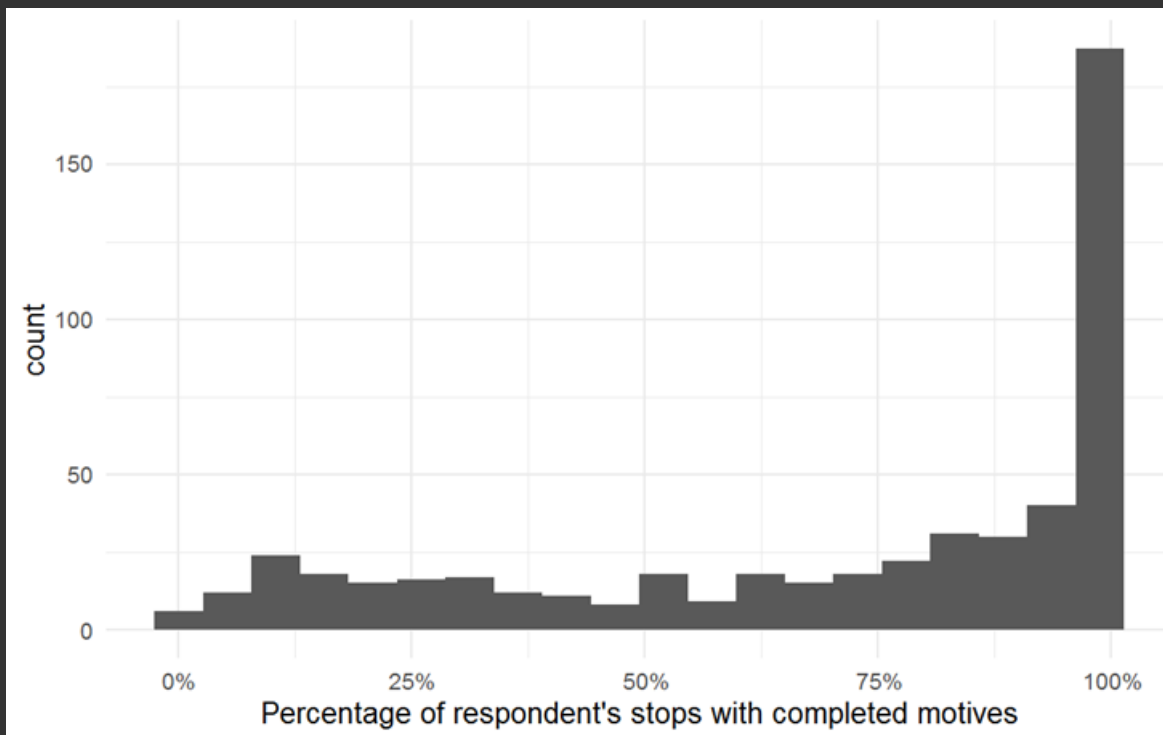
**“DOZE ON THE GO”**



**TIME GAPS BY ANDROID VERSION, ALL DAYS**

## SECTION 4

# A DIFFERENT SORT OF DROPOUT

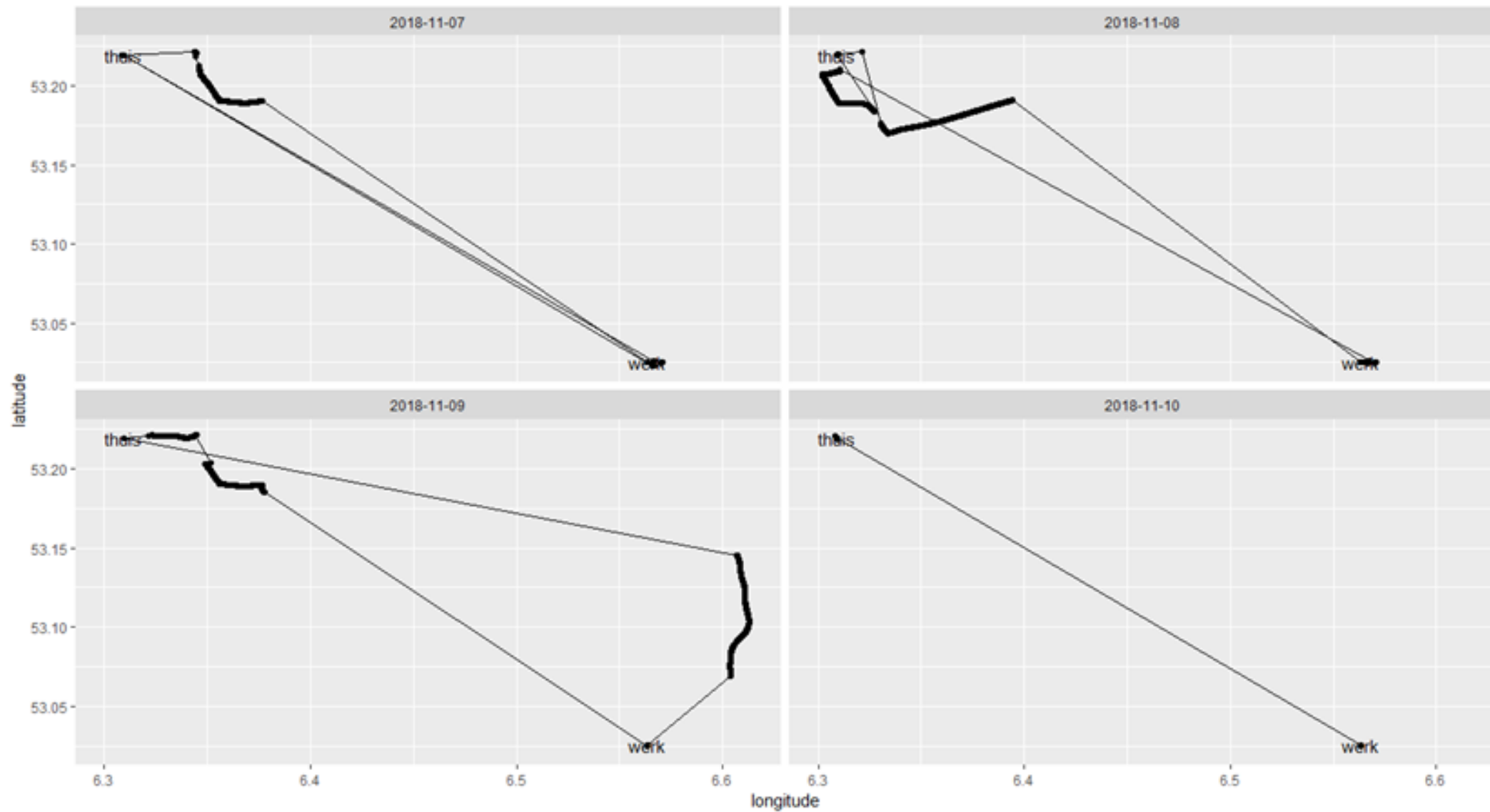


**GOOD LABELING OF STOPS AND TRACKS**

# QUESTIONS

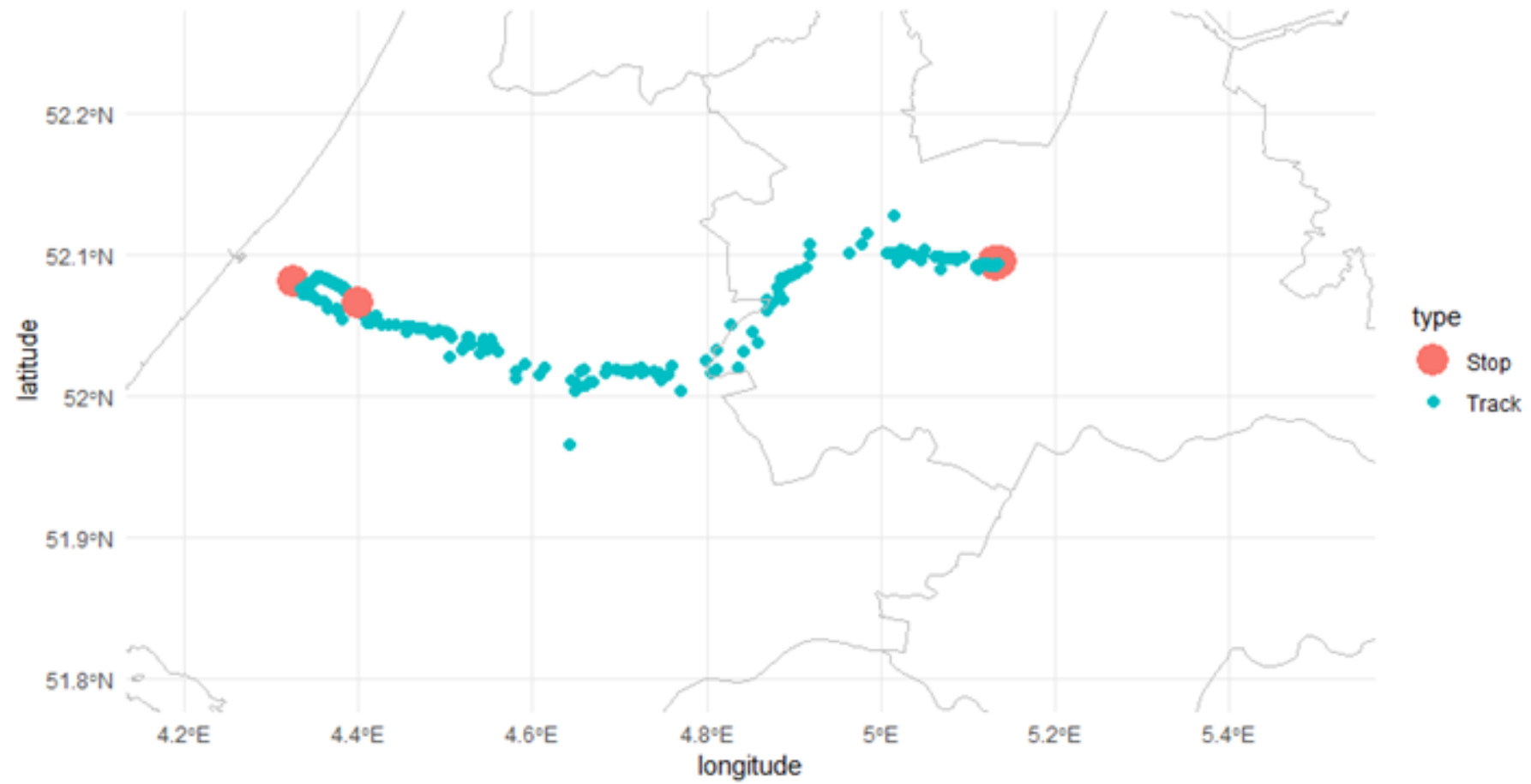
- **WHAT ARE OTHER WAYS TO JUDGE DATA COMPLETENESS?**
- **HOW CAN WE KNOW IF THE MISSING DATA IS INFORMATIVE?**

# EXTRAS

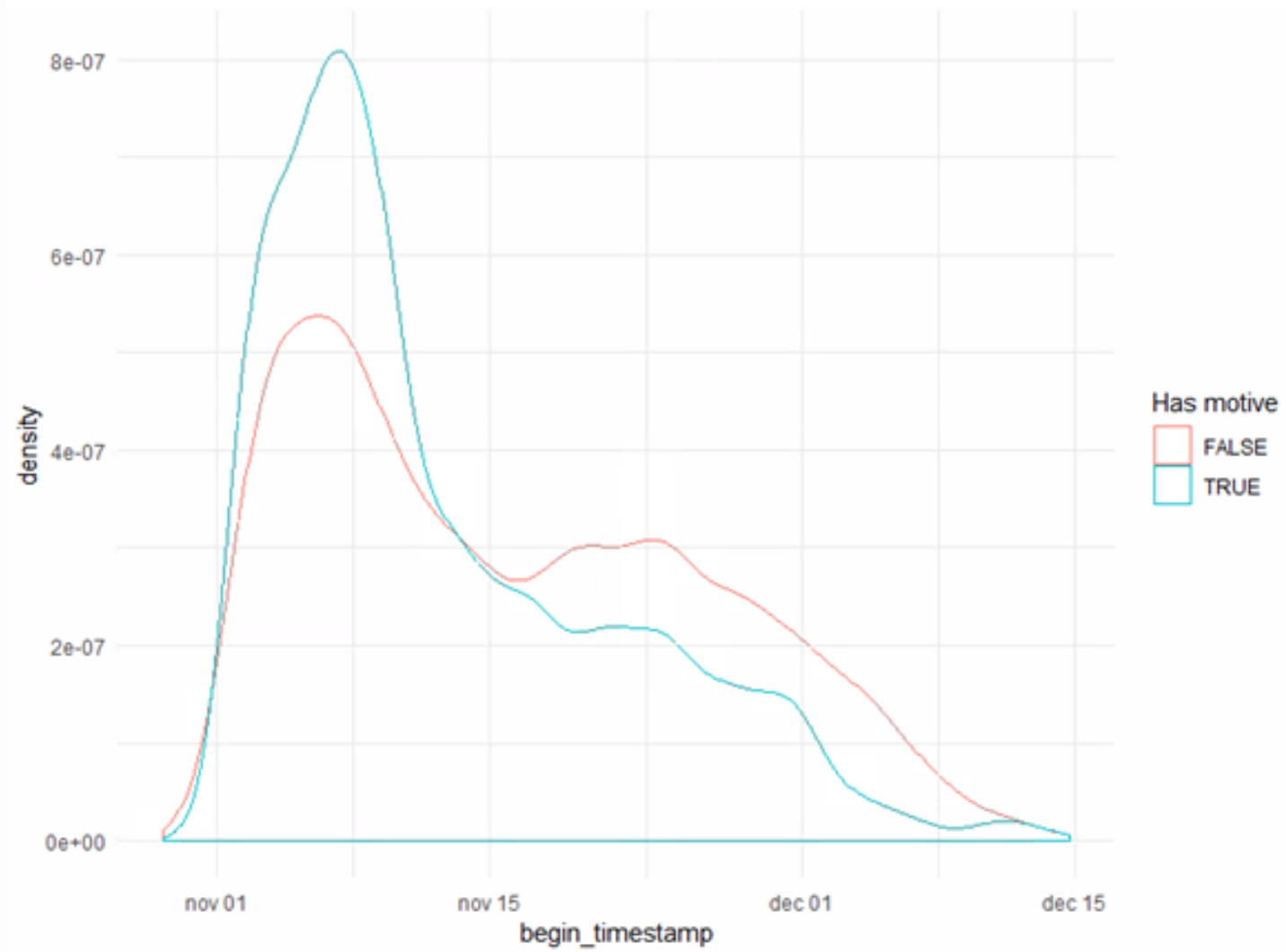


## THE STRAIGHT-LINE PROBLEM





## STOPS AND TRACKS



**MOTIVES OVER TIME**