Smartphones: From Surveys to Sensors

Vera Toepoel
(Utrecht University, v.toepoel@uu.nl)

BaNoCoSS2019
17 June 2019, Orebro


2005
Luca Bruno / AP


2013
NBC NEWS
Michael Sohn / AP

Mixed-device surveys

- Web survey are now mixed-device surveys
  - 50-80% of population use a smartphone
  - 5-30% of web responses are on mobile
  - Respondents still opt for PC/laptop/tablet
- How to deal with this?
  - Design PC first 
    - » Adapting existing survey to smartphone is not optimized!
  - Design smartphone-first
    - » If it looks good on a smartphone it looks good on a PC
  - Optimize per device
- Think about:
  - Survey length
  - Visual design
    - » Screensize + keyboard are different

AAPOR Report on mobile technologies 2014

- Match the tools and tasks to respondents
  - Match technology with population
- Follow established guideliness for contacting cell phones
  - Safe (not driving), private
- Recognize online surveys are mixed-device surveys
  - Use paradata (user agent strings) to find out potential bias
- Keep it short and simple
  - Mind connectivity, difficulty of using touchscreen, fast messaging
- Understand limits of mobile as a multimode platform
  - Benefits, challenges and potential error in voice, text-messaging, QR-codes, GPS, apps etc.
- Pretesting is essential!
  - User interface, functionality, operating systems, phone models

1. Survey length

Respondents are not willing to do long surveys on mobiles

TIME WILLING TO SPEND ON SURVEYS

65% of US Smartphone users would not be willing to spend more than 15 minutes completing surveys

MAXIMUM TIME DOING SURVEYS:	COMPUTER	TABLET	SMARTPHONE
5 minutes or less	2%	9%	27%
10 minutes or less	9%	24%	45%
15 minutes or less	19%	42%	65%
20 minutes or less	34%	65%	73%
25 minutes or less	42%	71%	77%
30 minutes or less	65%	81%	85%

US data from 1185 completes November, 2012

Taken from: Kelley, 2013

Mobile or Mixed-device survey

- Shorter surveys
  - 10 minutes or less
- Split surveys –data stitching
  - break the survey into parts (chunking), fielding each portion separately, combining parts into one holistic data analysis (stitching). Smaller chunks can be device agnostic or mobile only
    - » Across or within respondents

2. Mobile survey design

Invitations for mobile

- Many ways to reach respondents
  - » Consent?
  - » Pre-established relationship with respondent
  - RDD (random sample)
  - Email
  - QR Codes
  - Text-SMS
  - App
    - » Convince people to download app
    - » Built to fit device type
  - Location-based (beacons)
    - » Rely on GPS chip in phone

Browser versus app-based

	Mobile app	Mobile web smartphone	Mobile web feature phone
Categorical questions	X	X	X
Multiple responses	X	X	X
Sliders	X	X	
Grid		X	
Long list	X	X	
Open-ended	X	x	
barcodes	X		
GPS	X		
Picture	X		
Video	X		
Clickable image		X	
Ideal length	<10 MIN	<10 MIN	<15 SCREENS

Browser versus app based

- Apps can deploy more advanced features
  - images, streaming video (see Buskirk & Andrus, 2012)
- Apps need to be installed…
- Satisfaction is higher for apps
  - Maybe people who go through the extra step of downloading an app are more engaged…

Optimized versus not-optimized

- Look and feel
  - Use device detection to display appropriately for screen size
  - Easily read questions and select responses without having to zoom or switch orientation
  - Simple question types
    - » Without technical glitches
    - » Without extra gestures
  - Touch-friendly
    - » Higher respondent satisfaction
    - » Reduce missing data
    - » Less measurement error (e.g. straightlining)

How to optimize (see Antoun et al, 2017)

- Larger fonts
- Content fits to width of screen
  - No horizontal scrolling
- Response options displayed as wide buttons (tiles)
  - Pictograms for visual relief
- One question per page *(I disagree…I would say: no grids)*
- Grid split into individual items
  - Response options switch from horizontal to vertical (!!!)
- Auto-advance function
- Eliminate elements
  - Few visual distractions as possible (images, progress bars, <>)
  - Reduce page-load delays

No long introduction text

Add pictograms for visual relief

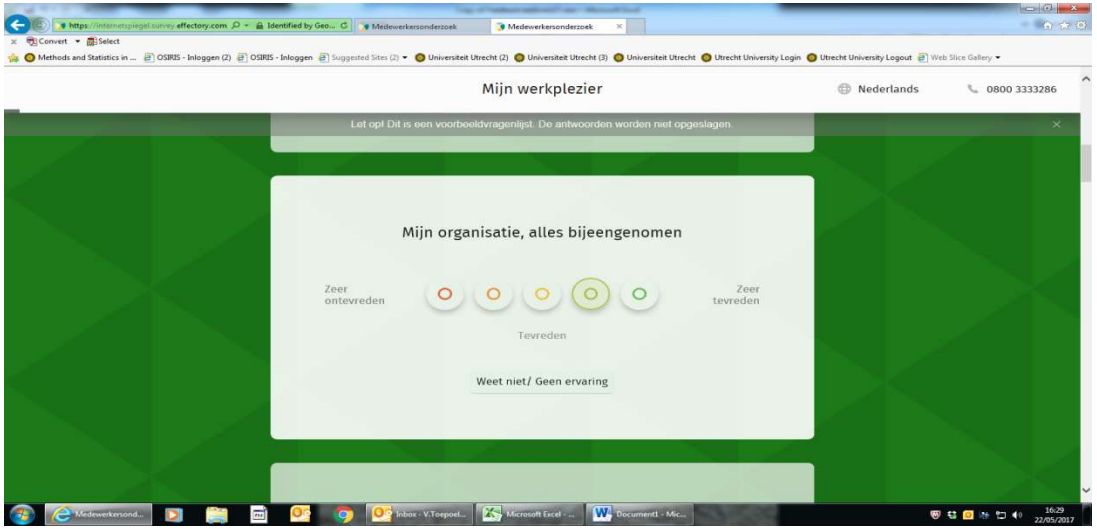
So….
-do not use unnecessary images
-replace text by informative images

KEEP IT CLEAN AND EASY!

Pictogram, tiles, touch

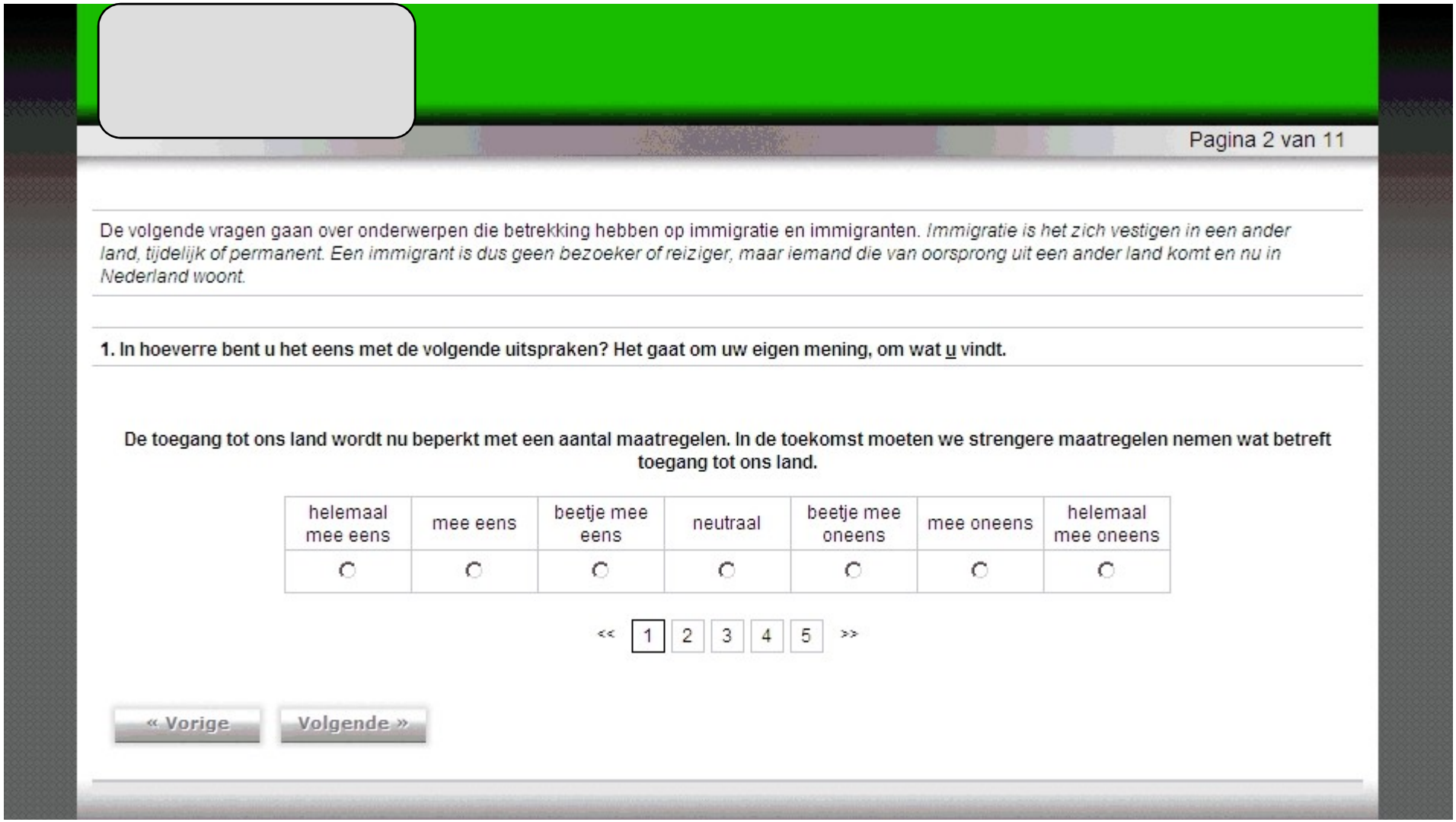
Grids: don't or design carefully

- Don't have the answer options go off the screen
- Ask the items in the grid one at a time
- Keep the response options stable
- Accordion format (collapsable chunks)
- Carousel format (items pass by)



Design For Mobile: Caroussel

(see Klausch et al.)



Pagina 2 van 11

De volgende vragen gaan over onderwerpen die betrekking hebben op immigratie en immigranten. *Immigratie is het zich vestigen in een ander land, tijdelijk of permanent. Een immigrant is dus geen bezoeker of reiziger, maar iemand die van oorsprong uit een ander land komt en nu in Nederland woont.*

1. In hoeverre bent u het eens met de volgende uitspraken? Het gaat om uw eigen mening, om wat u vindt.

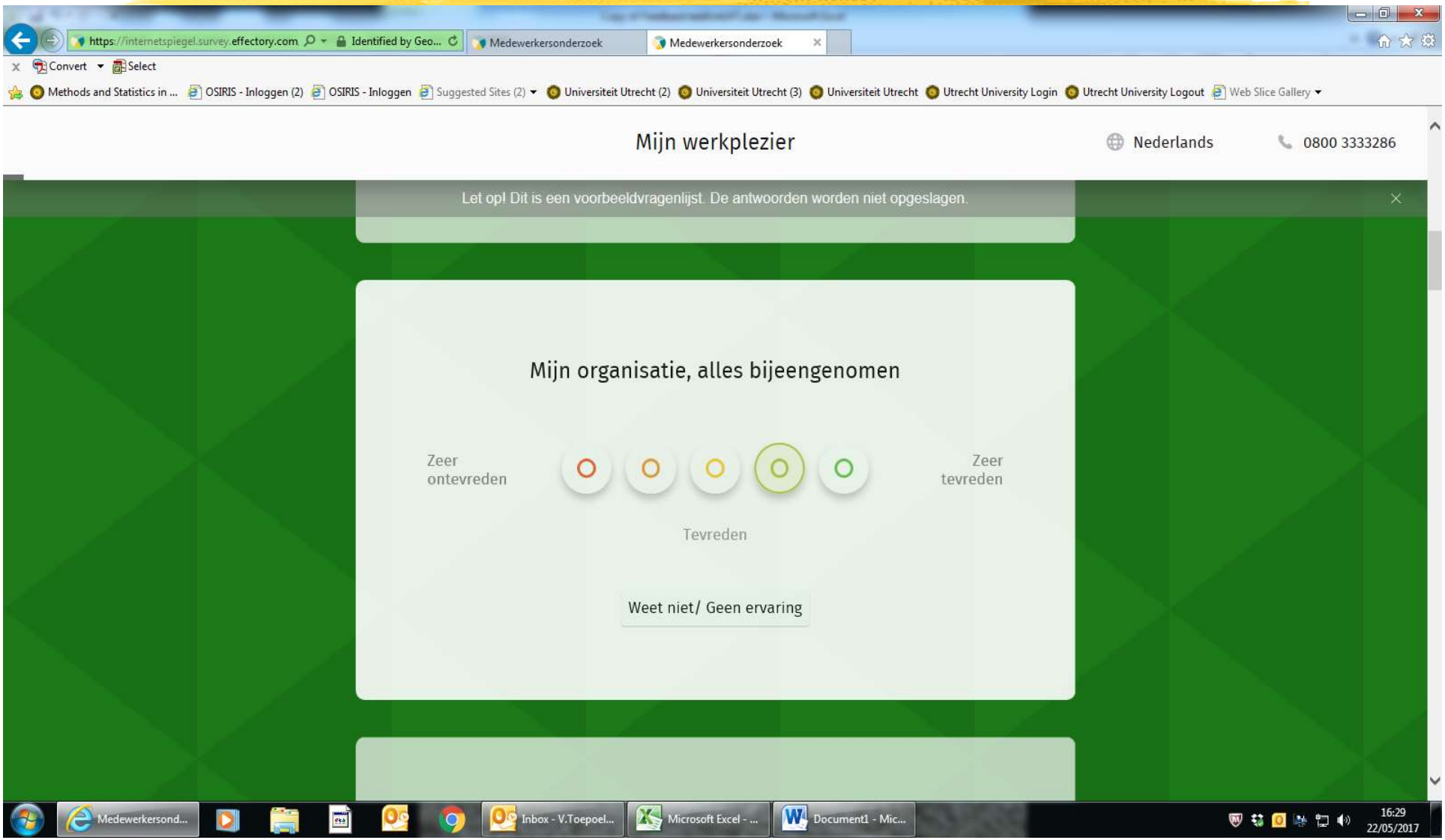
De toegang tot ons land wordt nu beperkt met een aantal maatregelen. In de toekomst moeten we strengere maatregelen nemen wat betreft toegang tot ons land.

helemaal mee eens	mee eens	beetje mee eens	neutraal	beetje mee oneens	mee oneens	helemaal mee oneens
○	○	○	○	○	○	○

<< 1 2 3 4 5 >>

« Vorige Volgende »

Visual relief: (vertical) accordion versus traditional grid

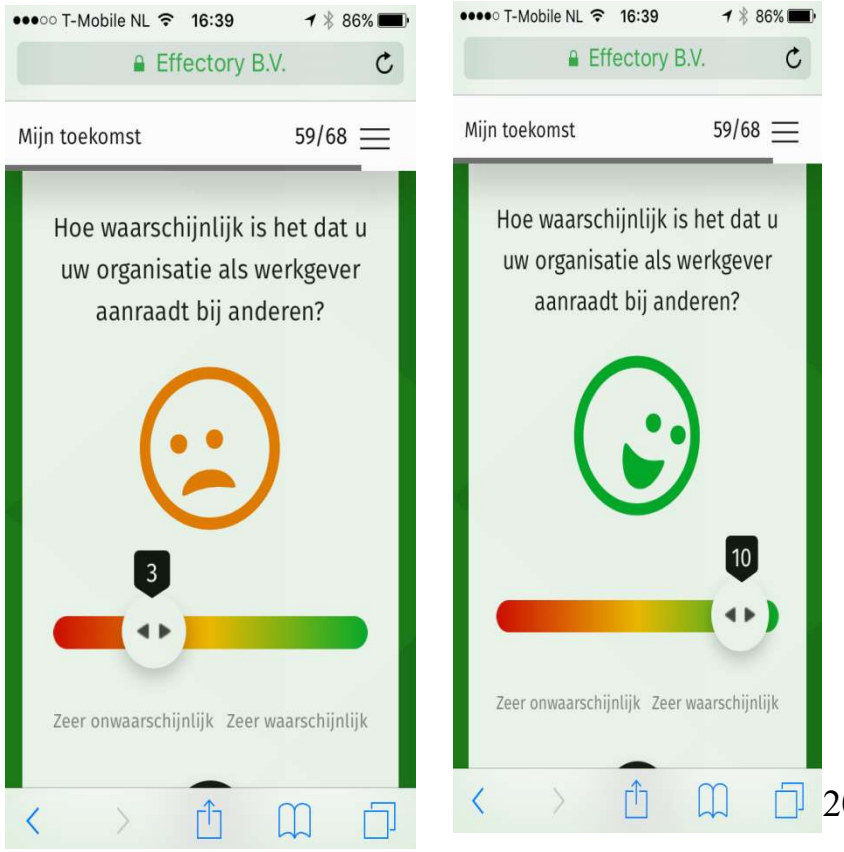


Bars

- Better evaluated on mobile (see Toepoel and Funke, 2018, Mathematical Population Studies)
- Visual analogue scale
  - Point and click

versus

- Slider bar
  - Drag and drop
  - Initial position handle might influence results - Special design



Bars

- With point and click
- Takes less space on a screen
- More categories possible
  - Every pixel is a response option

For mobile: do not use dropdown menu: varies by browser

Radio buttons

Drop-down

All Devices/ Browsers

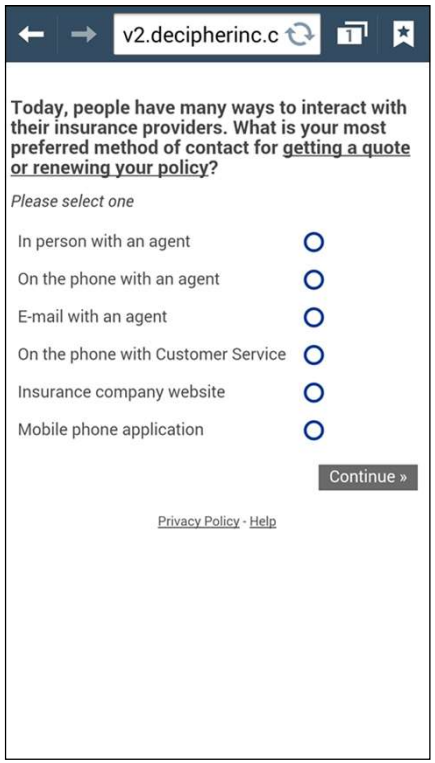
iPhone

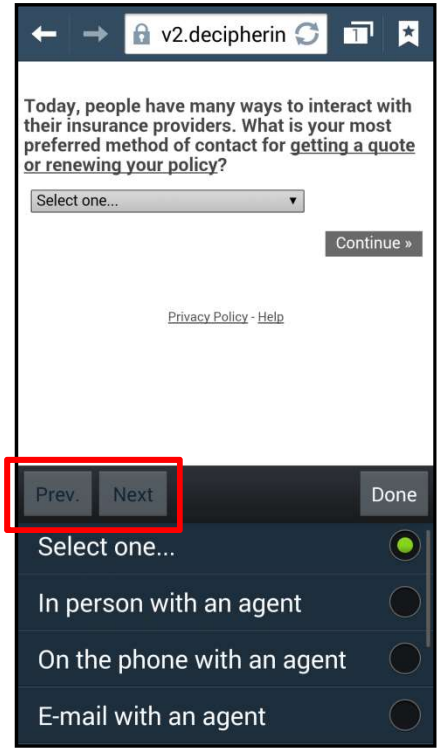
Android

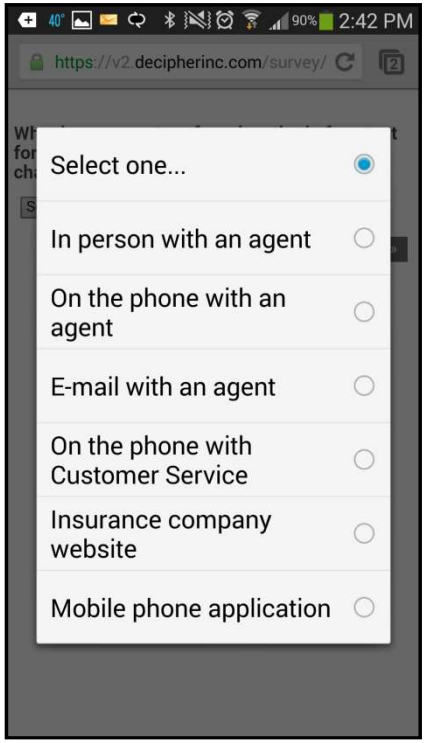
Safari Browser

Default Browser

Chrome/Firefox



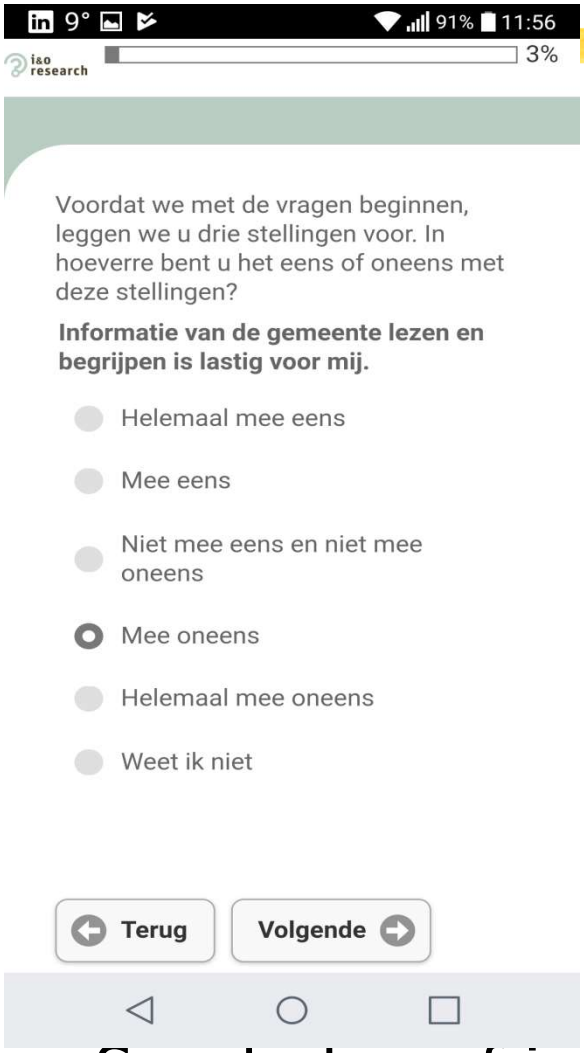


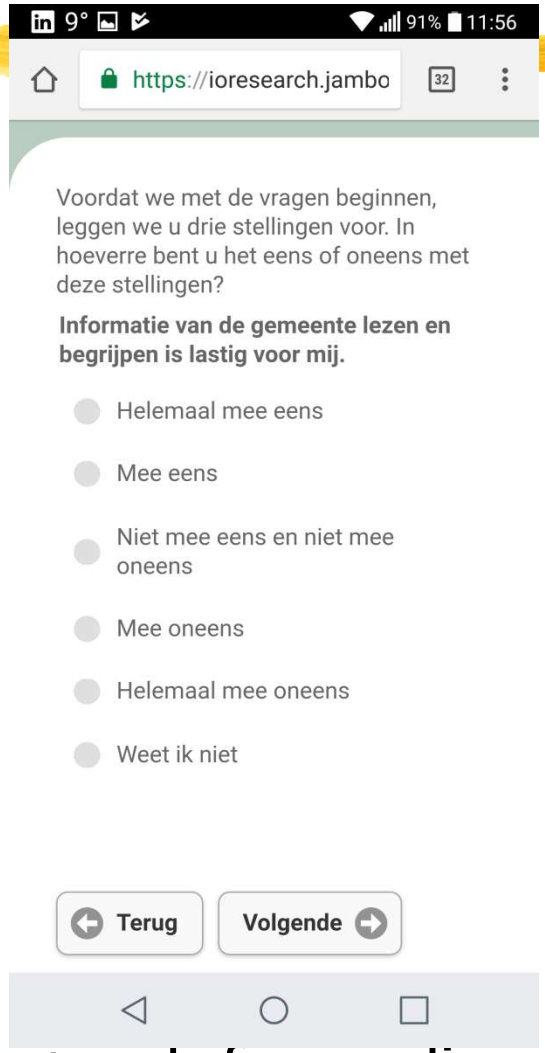


Why not to use dropdown menus

- Different on Apple and Android devices
- Longer completion times
- Higher item missing rates
- Larger primacy effects
- Long response options sometimes get truncated
  - "Neither agree nor dis…
- First response option follows last one on the wheel

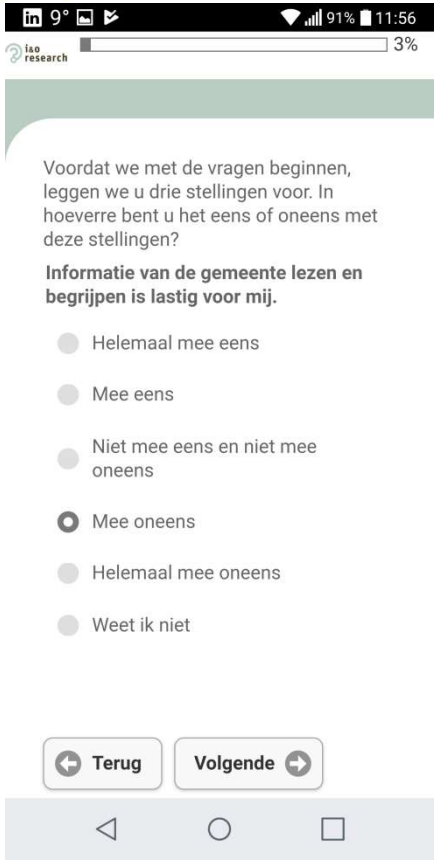
Autoforwarding – what is it?

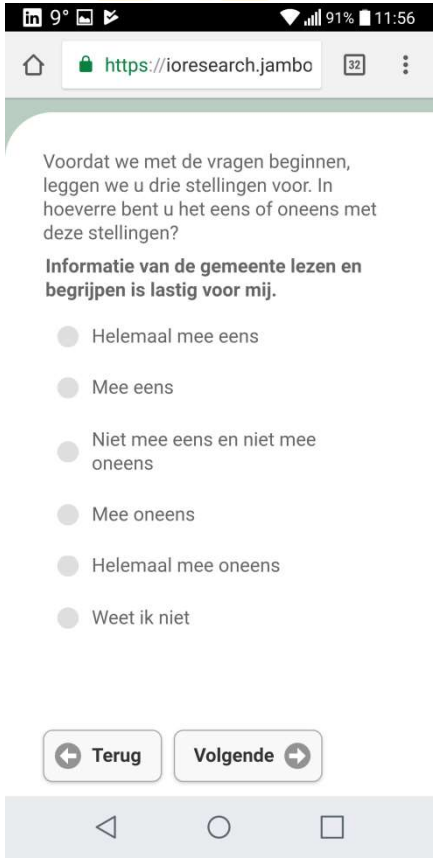




- Smart-phone friendly + autoforwarding

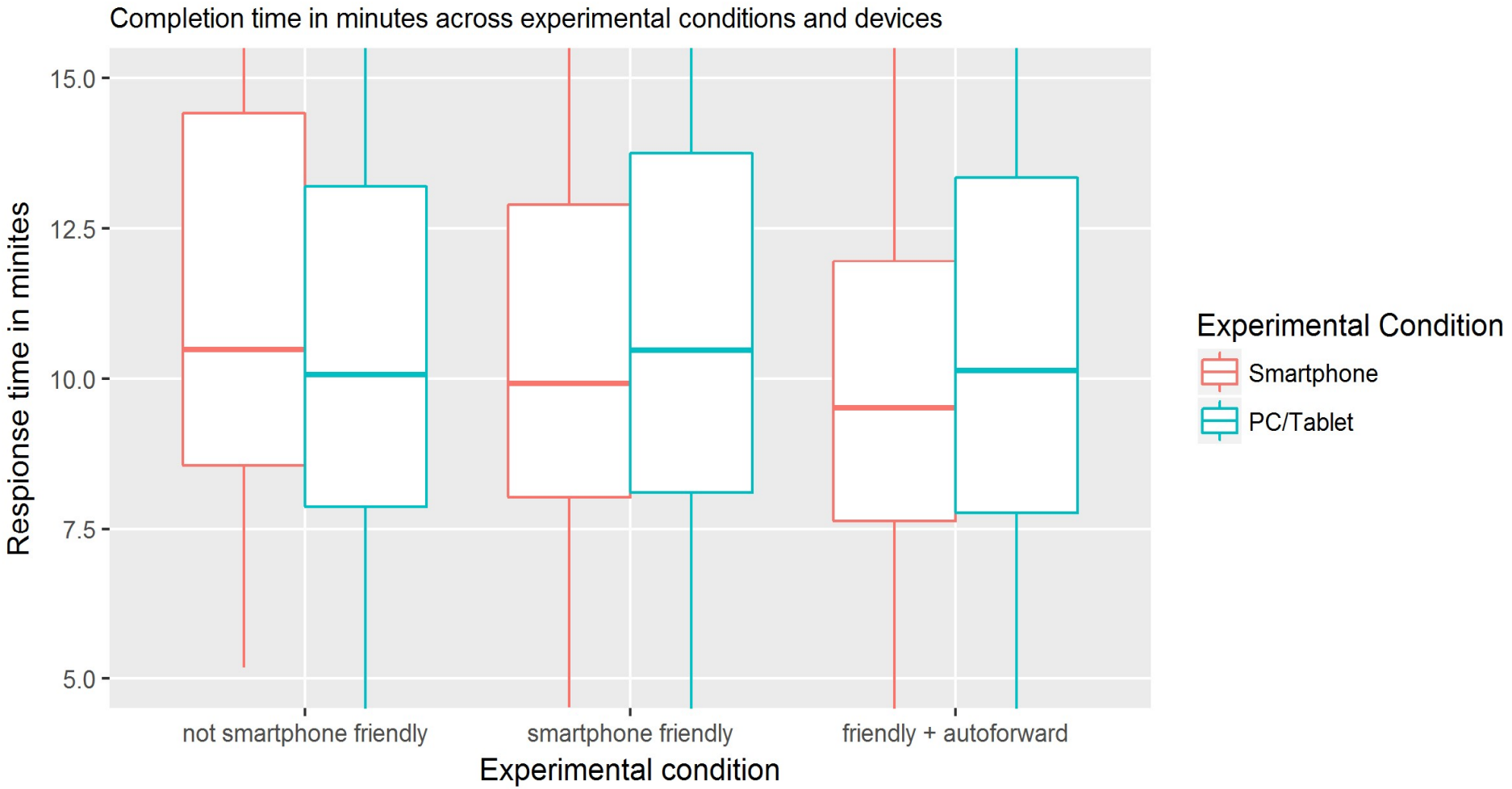
Autoforwarding – Experiment





- Unfriendly
- Smart-phone friendly
- +autoforwarding

Results experiment I&O Research: Duration reduced on mobiles



My point of view: THINK about design

- Optimal design may change over the years
- I went from hating smileys into loving smileys
- Society has changed (e.g. use of emoji's)
- Be careful though…

Takeaway: mobile surveys

- Considerable amount uses mobile (about 25%)
- Design for mobile first
  - Take design rules into account
- WHEN DESIGNED OPTIMALLY
  - Little/No effect on non-response
  - Little/No effect on response quality
  - Similar evaluation
  - No reason to believe that mixed-device is a problem
- Able to attract hard-to-reach group such as young people (Toepoel and Lugtig, 2015, 2016)

References: mixed-device surveys (1)

- Antoun, C., Katz, J., Argueta, J., & Wang, L. (2017). Design Heuristics for Effective Smartphone Questionnaires. *Social Science Computer Review*, 0894439317727072.
- Arn, B. S. Klug and J. Kolodziejski. 2015. Evaluation of an adapted design in a multi-device online panel. Methods, data, analysis, 9, 2, 185-2012.
- Bosnjak, M., Bauer, R., & Weyandt, K. W. (2018). Mixed Devices in Online Surveys: Prevalence, Determinants, and Consequences. In Theorbald, A. (ed). *Mobile Research* (pp. 53-65). Springer Gabler, Wiesbaden.
- Buskirk, T.D. and C.H. Andrus.2014. Making Mobile Browser Surveys Smarter. Results from a Randomized Experiment Comparing Online Surveys Completed via Computer or Smartphone. Fieldmethods, 26,4, 322-342.
- Couper, M. P., Antoun, C., & Mavletova, A. (2017). Mobile Web Surveys. *Total Survey Error in Practice*, 133-154.
- Couper, M. P., & Peterson, G. J. (2017). Why do web surveys take longer on smartphones?. *Social Science Computer Review*, *35*(3), 357-377.
- De Bruijne, M. and A. Wijnant. 2014a. Improving response rates and questionnaire design for mobile web surveys. Public Opinion Quarterly, 78, 4, 951-962.
- Halder, A., H.S. Bansal, R. Knowles, J. Eldridge and M. Murray. 2016. Shorter interviews, longer surveys. Optimising the survey participant experience whilst accommodating ever expanding client demands. Proceedings of the Association for Survey Computing, 7.
- Johnson, E.P. 2015. Mobile device and modular survey design.
- Lugtig, P., Toepoel, V., & Amin, A. (2016). Mobile-only web survey respondents. *Survey Practice*, *9*(4).

References: mixed-device surveys (2)

- Lugtig, P., V. Toepoel, M. Haan, R. Zandvliet & L. Klein Kranenburg (2019). Recruiting young and urban groups into a probability-based online panel by promoting smartphone use. Methods Data Analysis.
- Mac Ginty, R., & Firchow, P. (2017). Including Hard-to- Access Population Using Mobile Phone Surveys and Participatory Indicators. *Sociological Methods & Research*. DOI: 10.1177/0049124117729702
- Mavletova, A. and M. P. Couper. 2015. A meta-analysis of breakoff rates in mobile web surveys. In: Toninelli, D. Pinter, R., and de Pedraza, P. (eds) Mobile Research Methods: Opportunities and Challenges of Mobile Research Methodologies, pp81-98. London: Ubiquity Press.
- Mavletova, A., Couper, M. P., & Lebedev, D. (2017). Grid and Item-by-Item Formats in PC and Mobile Web Surveys. *Social Science Computer Review*, 0894439317735307.
- Toepoel, V. and F. Funke (2018). Sliders, Visual Analogue Scales, or Buttons: Influence of formats and scales in mobile and desktop surveys. Mathematical Population Studies
- Toepoel, V. and P. Lugtig. 2015. Online surveys are mixed-device surveys. Methods, Data, Analysis, 9, 2, 155-162.
- Toepoel, V. and P. Lugtig. 2014. What Happens if You Offer a Mobile Option to Your Web Panel? Evidence from a probability-based panel of Internet users. Social Science Computer Review, 32, 4, 1-17.
- Toepoel, V., B. Vermeeren & B. Metin (2019) Smileys, stars, hearts, buttons, tiles or grids: influence of response format on substantive response, questionnaire experience and response time. Bulletin Methodology Sociologique
- Wells, T., J. Bailey, and M.W. Link. 2013. Comparison of smartphone and online computer survey administration. Social Science Computer Review, 32,2, 238–255.

Part 2

Using mobiles to go beyond the traditional survey:

Sensor data

New data collection opportunities through smartphones

- Sensor/passive measurement: e.g., geolocation & physical movements, online behavior, app usage, social media usage, encrypted calls & text messages
- Experience Sampling Methods / Ecological assessment (Fischer 2009)
- Wearables connecting with bluetooth (Link et al. 2014)

Benefits: Replacing & Augmenting Surveys

- Eliminate recall error
- Lower respondent burden
- Better data (more frequent + better quality)

32

Challenges…

- 1. Are people willing to do this?
  - Nonresponse error
- 2. How to measure behaviors/facts?
  - What are sensor data good for?
- 3. How to collect these data?
  - Building an app
- 4. what to do with the data?
  - Analyzing sensor data

Part 2

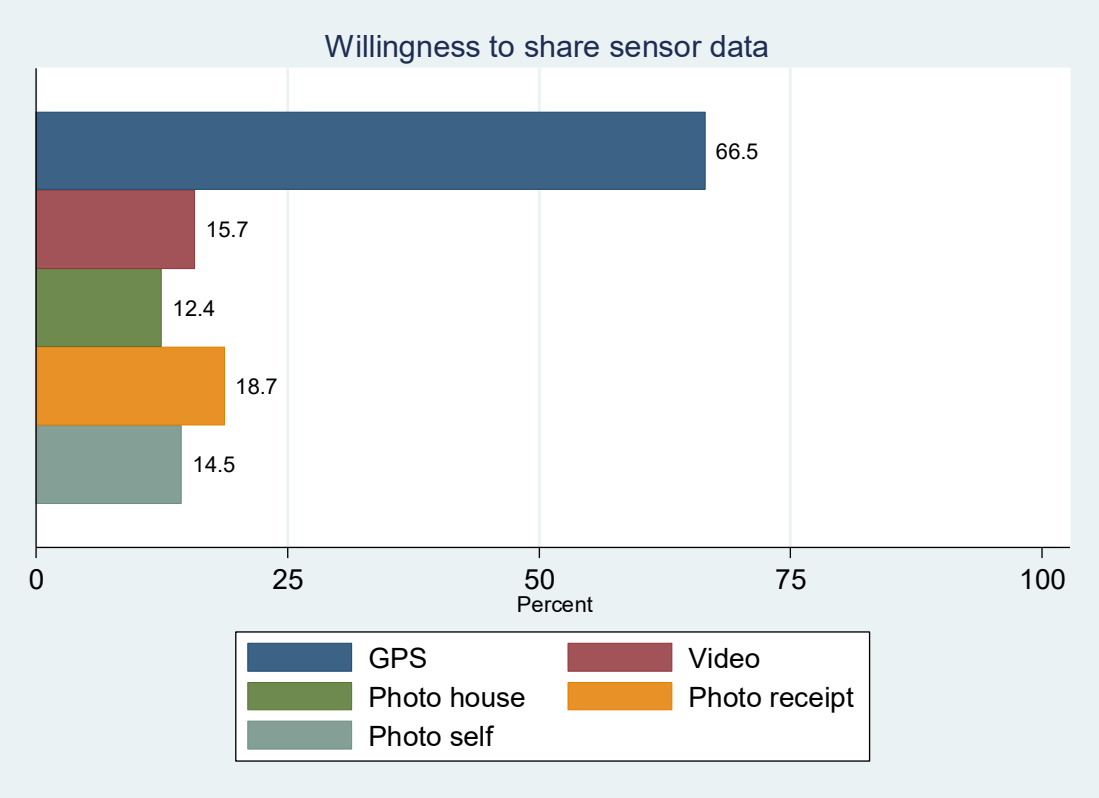
1. Are people willing to do this?

Research gap & previous research

Under what conditions are respondents willing to share sensor data?

- Sponsor: University rather than market research (Keusch et al. 2017)
- Control: Willingness higher for tasks where respondents have control over the reporting of the results, even if this means more effort (Revilla, Couper & Ochoa, 2017)
- Smartphone skills & specific SP activities (Couper et al. 2017; Eleve Keusch et al. 2017; Wenz et al. 2017)
- Previous app download: higher willingness (Keusch et al. 2017)
- Privacy / security concerns (Jäckle et al. 2017; Keusch et al. 2017; Revilla et al. 2017; Wenz et al. 2017)

CBS Consent Survey: Willingness



n = 1,883 Dutch smartphone & tablet users

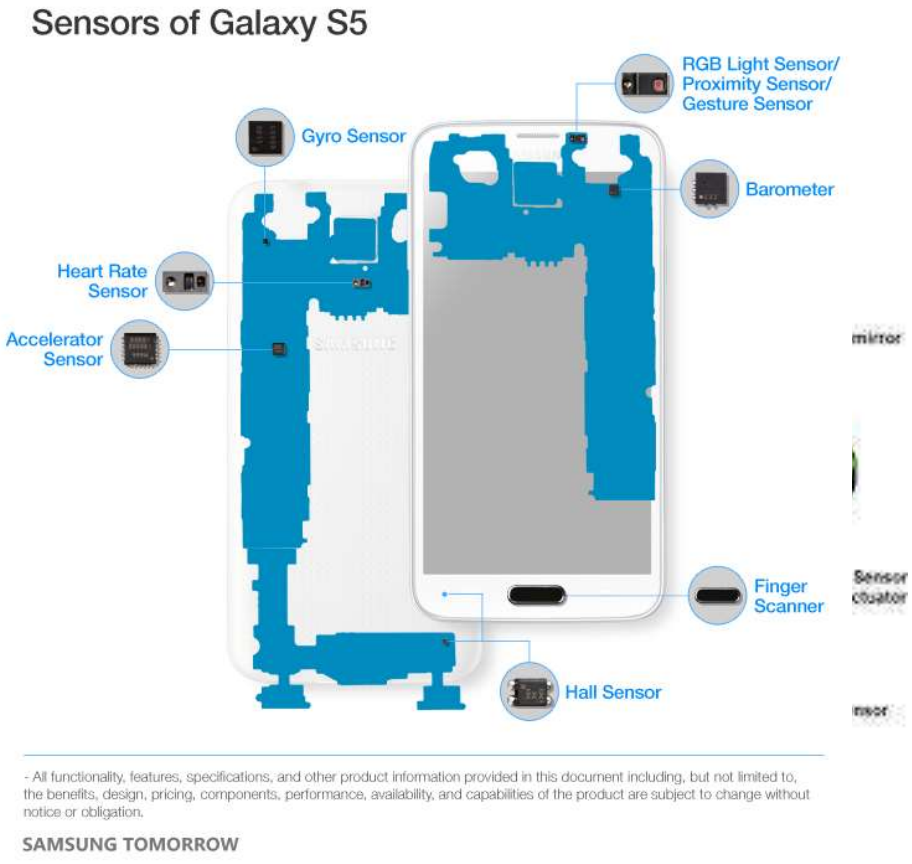
*Struminskaya et al. (2018)**

36

Part 2

2. Sensors, what can you measure?

Passive measurements



Which sensors are available?

- GPS
- Gyroscope, accelerometer, gravity
- 3d Touch
- Heartrate
- Pressure
- Proximity
- Bluetooth Wifi, cell network, NFC
- Temperature, light, hall-effect, Magnetic field

- Can be used through apps, JavaScript, or html5

Examples of use of sensors: networks

- Combination of bluetooth and wifi to determine whether schoolchildren interact

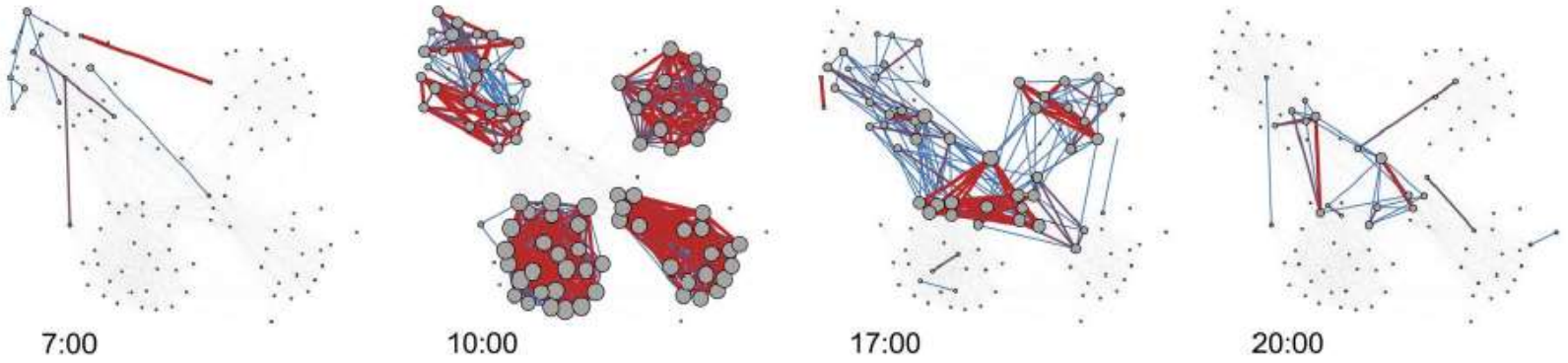


Figure 1. Dynamics of face-to-face interactions in the 2012 deployment. The participants meet in the morning, attend classes within four different study lines, and interact across majors in the evening. Edges are colored according to the frequency of observation, ranging from low (blue) to high (red). With 24 possible observations per hour, the color thresholds are respectively: blue ($0 <$ observations ≤ 6), purple ($6 <$ observations ≤ 12), and red (< 12 observations). Node size is linearly scaled according to degree.
doi:10.1371/journal.pone.0095978.g001

- Taken from Stopzynski et al

Examples of use of sensors: activity detection

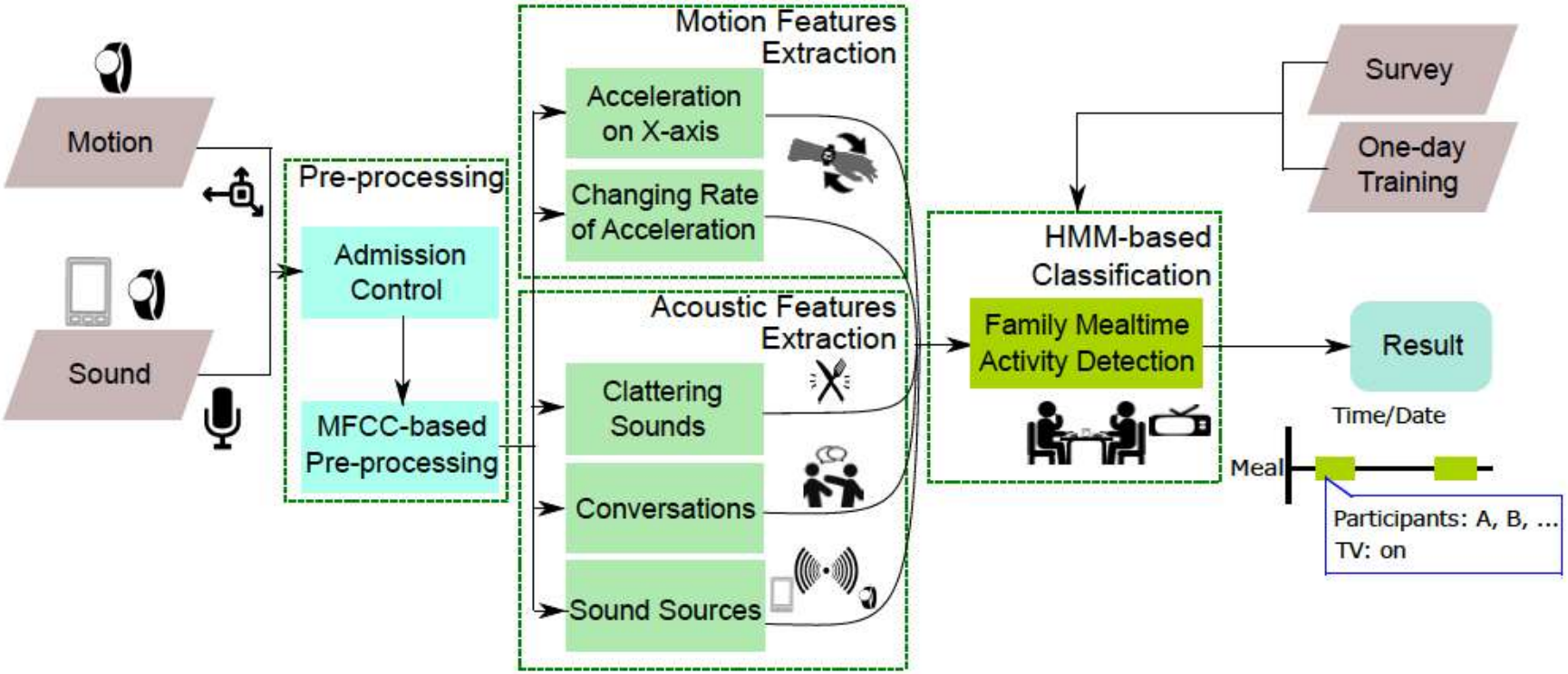


Fig. 1. System overview

- Accelerometer and microphone
- FamilyLog: Taken from Bi et al (2017)

Examples of use of sensor data: purchases

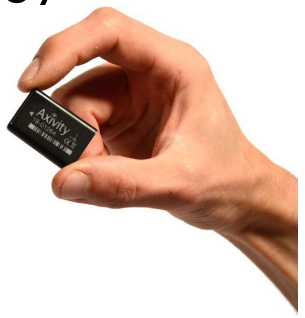
- Several organizations are using cameras to scan receipts (understanding society, official statistics)
- Work by Wenz, Jackle in Understanding Society (UK)

Examples of use of sensor data: acceleration data (2)

- Wearables
  - Wrist worn GENEActiv
  - Axivity ax3 at upper thigh

- (Total) Physical Activity

- UK Millennium Cohort Study: Gilbert & Calderwood (2018)
- SHARE: Scherpenzeel, Angleys, & Weiss (2018)

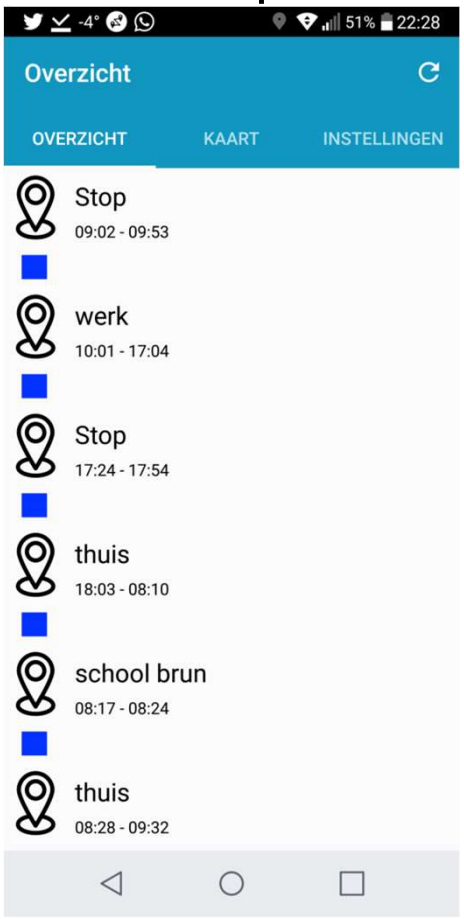


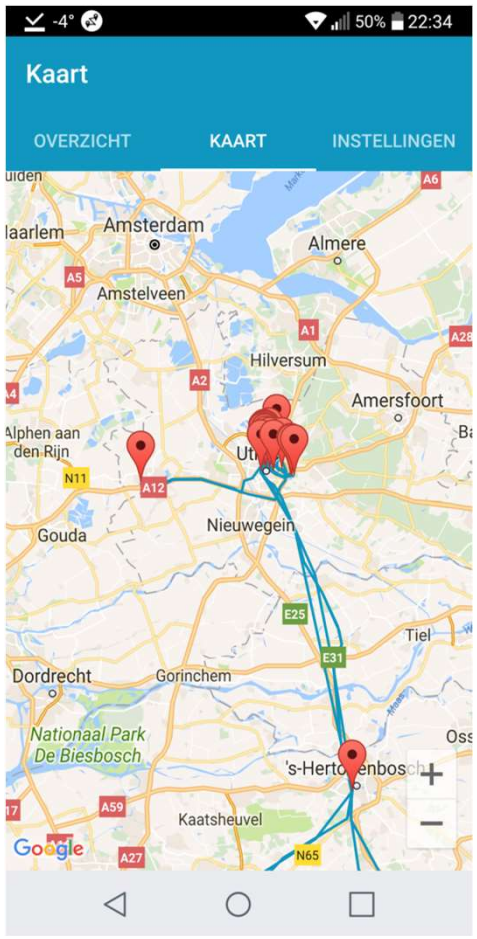
How to record sensor data?

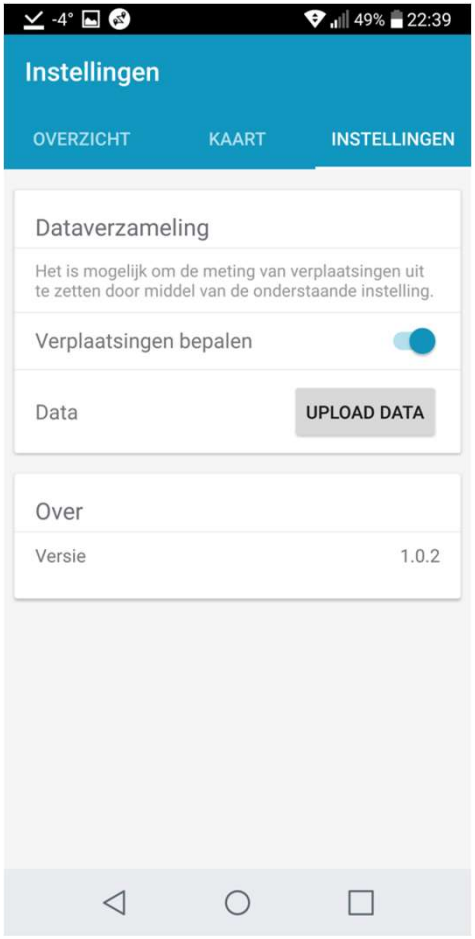
- Apps
- Through the browser

The Tabi app (with Statistics Netherlands)

- See https://gitlab.com/tabi/tabi-app
  - Open source, free for non-commercial use







Utrecht University

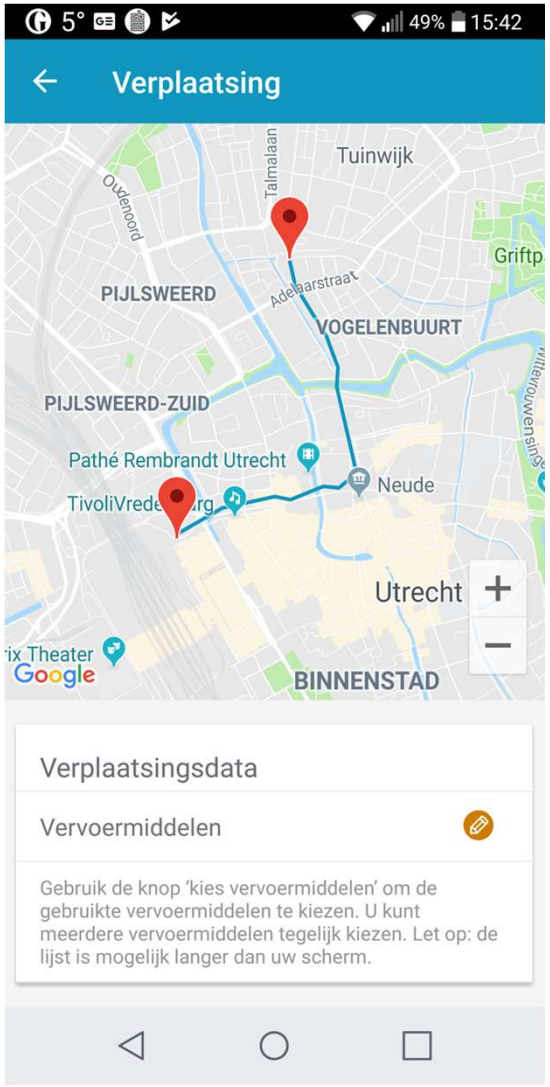
CBS App

Peter Lugtig, Barry Schouten, Danielle McCool, Katie Roth, Laurent Smeets, Ole Mussman, Victor Verstappen, Jelmer de Groot, Vera Toepoel, Deirdre Giesen, Annemieke Luiten, Bella Struminskaya, Vivian Meertens

Why an app?

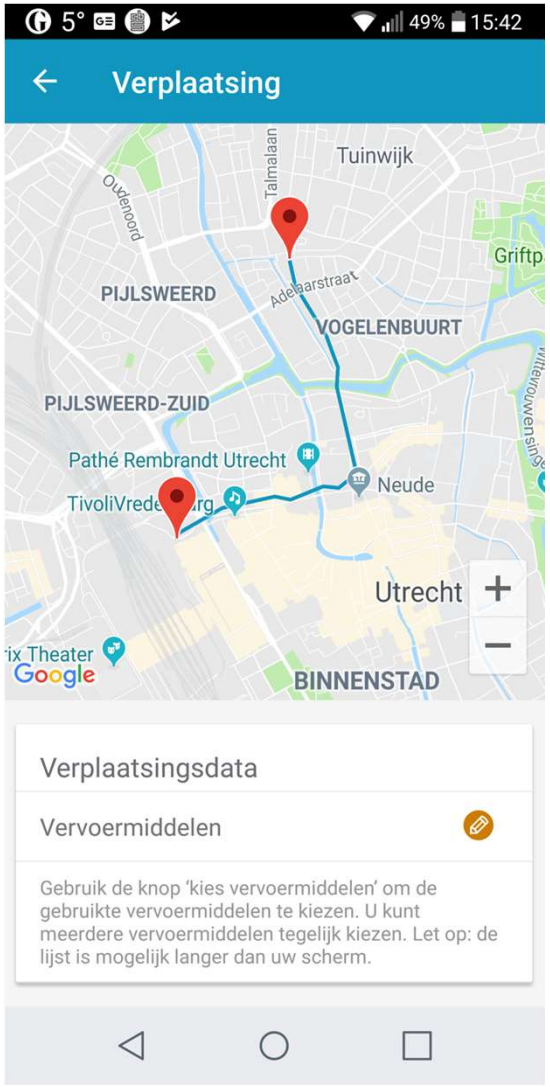
- More and better data data:
  - Stops
  - Mode of transport
  - Duration of trips

- Goal: to test the methodology of collecting data through apps
  - Test software + infrastructure
  - Are people willing to participate?
  - Who participates?
  - Data quality



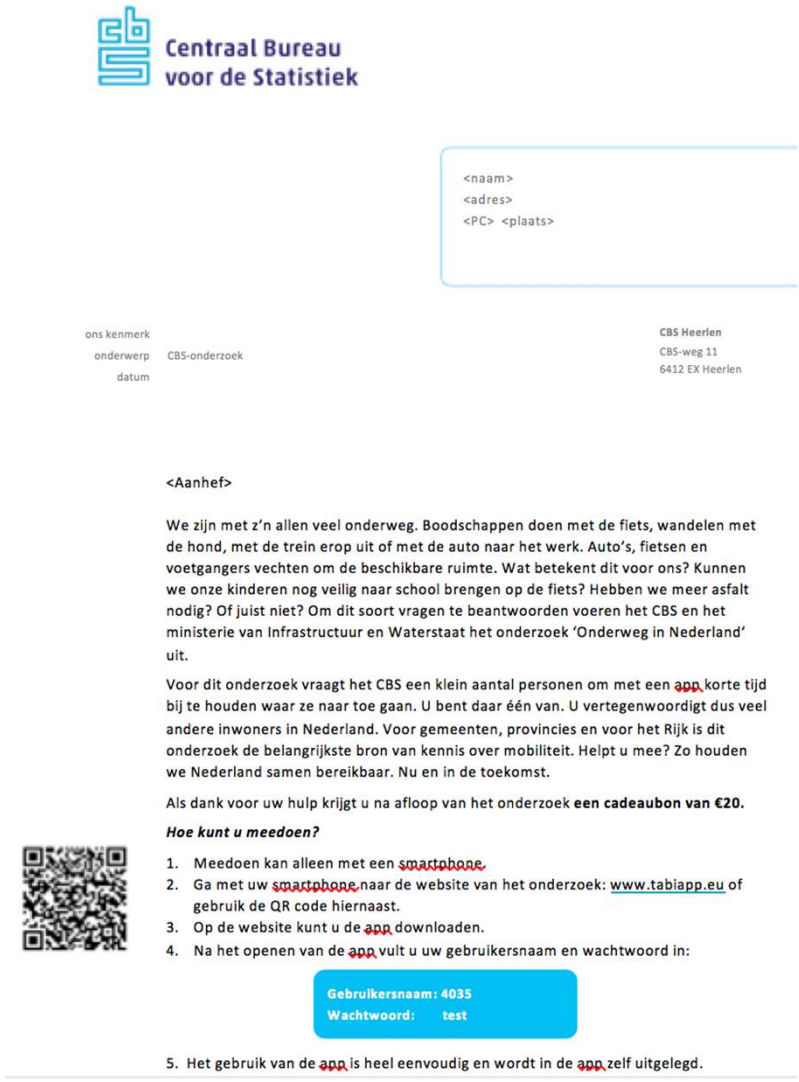
Goal (2016-2018)

- App open-source
  - https://gitlab.com/tabi/tabi-app
- App on all smartphones
  - In practice: Android and ioS ~2016
- App should have low respondent burden
  - Few questions
- Data quality is good
  - Nonresponse and measurement error



Fieldwork (1)

- Start 31 oktober 2018
- 1. Letter



Centraal Bureau
voor de Statistiek

<naam>
<adres>
<PC> <plaats>

ons kenmerk
onderwerp CBS-onderzoek
datum

CBS Heerlen
CBS-weg 11
6412 EX Heerlen

<Aanhef>

We zijn met z'n allen veel onderweg. Boodschappen doen met de fiets, wandelen met de hond, met de trein erop uit of met de auto naar het werk. Auto's, fietsen en voetgangers vechten om de beschikbare ruimte. Wat betekent dit voor ons? Kunnen we onze kinderen nog veilig naar school brengen op de fiets? Hebben we meer asfalt nodig? Of juist niet? Om dit soort vragen te beantwoorden voeren het CBS en het ministerie van Infrastructuur en Waterstaat het onderzoek 'Onderweg in Nederland' uit.

Voor dit onderzoek vraagt het CBS een klein aantal personen om met een app korte tijd bij te houden waar ze naar toe gaan. U bent daar één van. U vertegenwoordigt dus veel andere inwoners in Nederland. Voor gemeenten, provincies en voor het Rijk is dit onderzoek de belangrijkste bron van kennis over mobiliteit. Helpt u mee? Zo houden we Nederland samen bereikbaar. Nu en in de toekomst.

Als dank voor uw hulp krijgt u na afloop van het onderzoek **een cadeaubon van €20.**

Hoe kunt u meedoen?

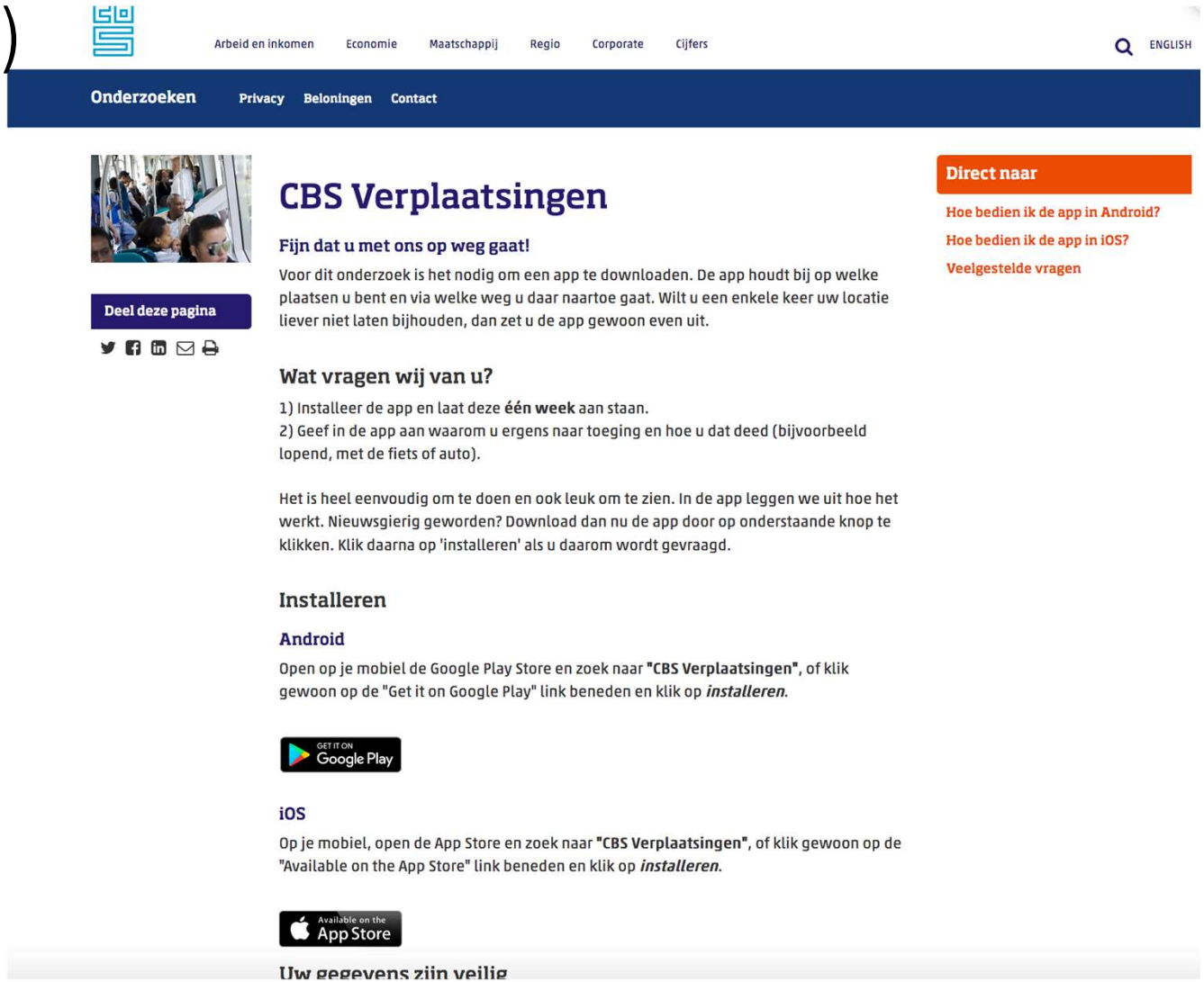
1. Meedoen kan alleen met een smartphone.
2. Ga met uw smartphone naar de website van het onderzoek: www.tabiapp.eu of gebruik de QR code hiernaast.
3. Op de website kunt u de app downloaden.
4. Na het openen van de app vult u uw gebruikersnaam en wachtwoord in:

Gebruikersnaam: 4035
Wachtwoord: test

5. Het gebruik van de app is heel eenvoudig en wordt in de app zelf uitgelegd.

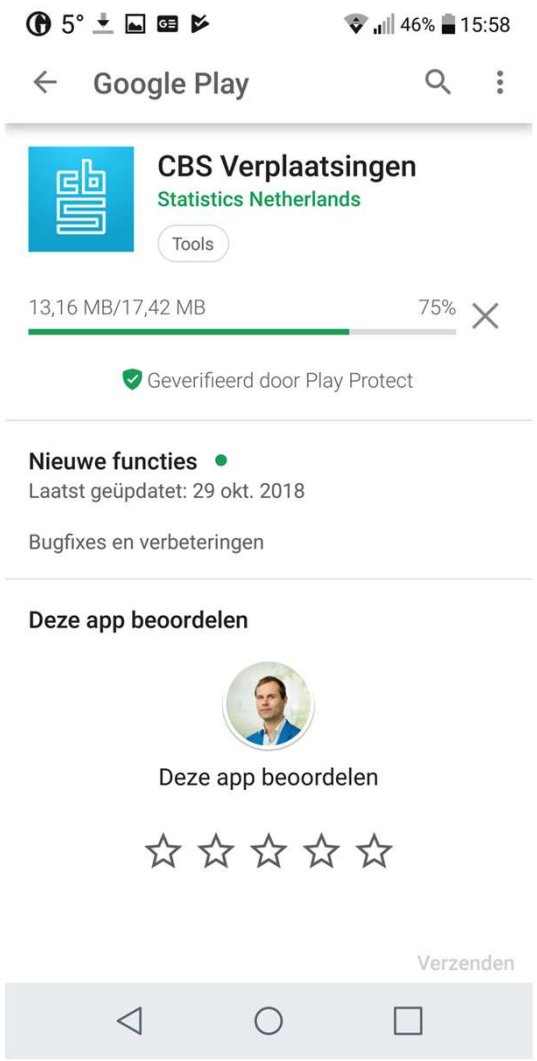
Fieldwork (2)

- Start 31 oktober
- 1. letter
- 2. website



Fieldwork (3)

- Start 31 oktober
- 1. letter
- 2. website
- 3. download app



Utrecht University

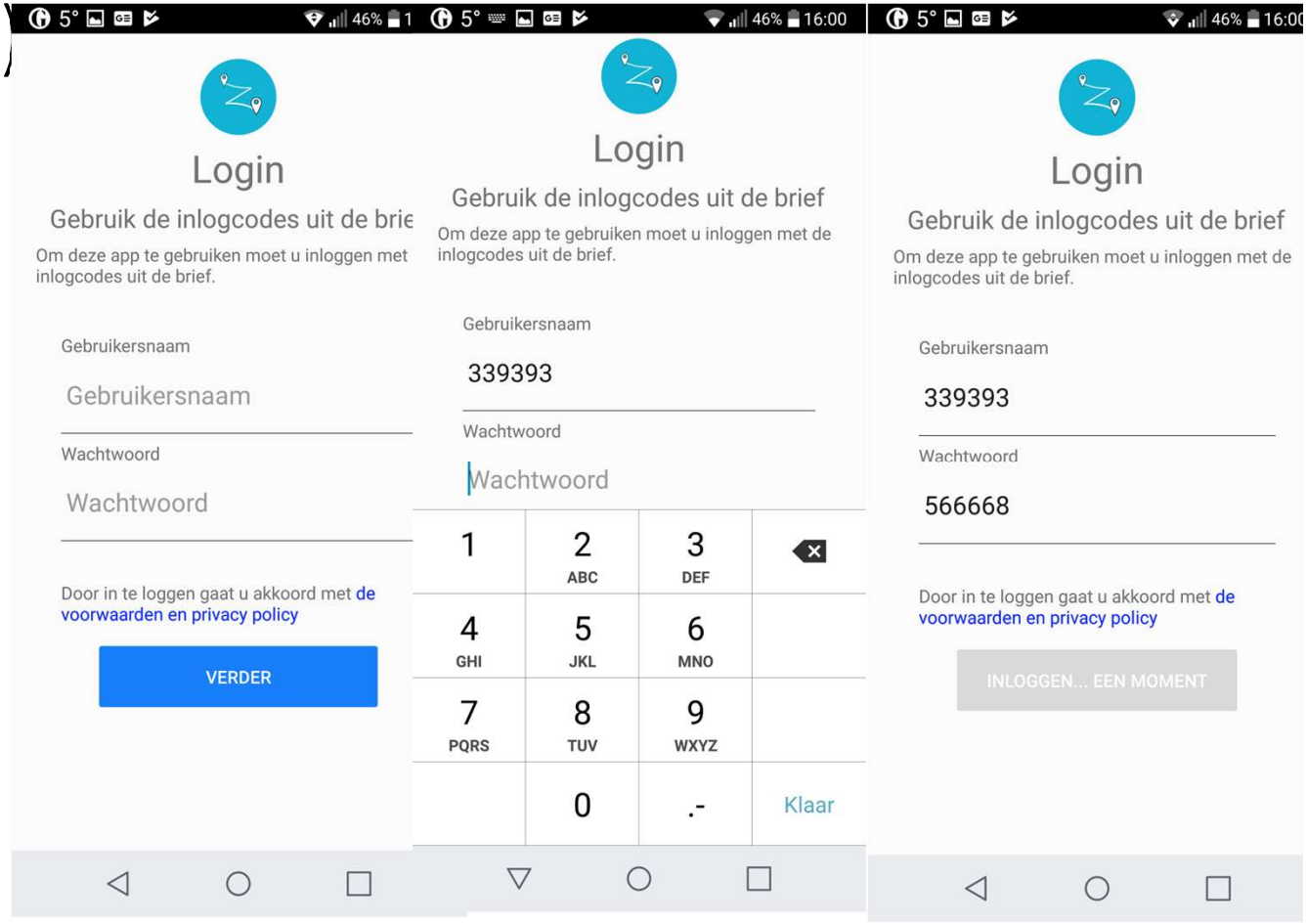
Fieldwork (4)

- Start 31 oktober
- 1. brief
- 2. website
- 3. download app
- 4. welcome screen

Utrecht University

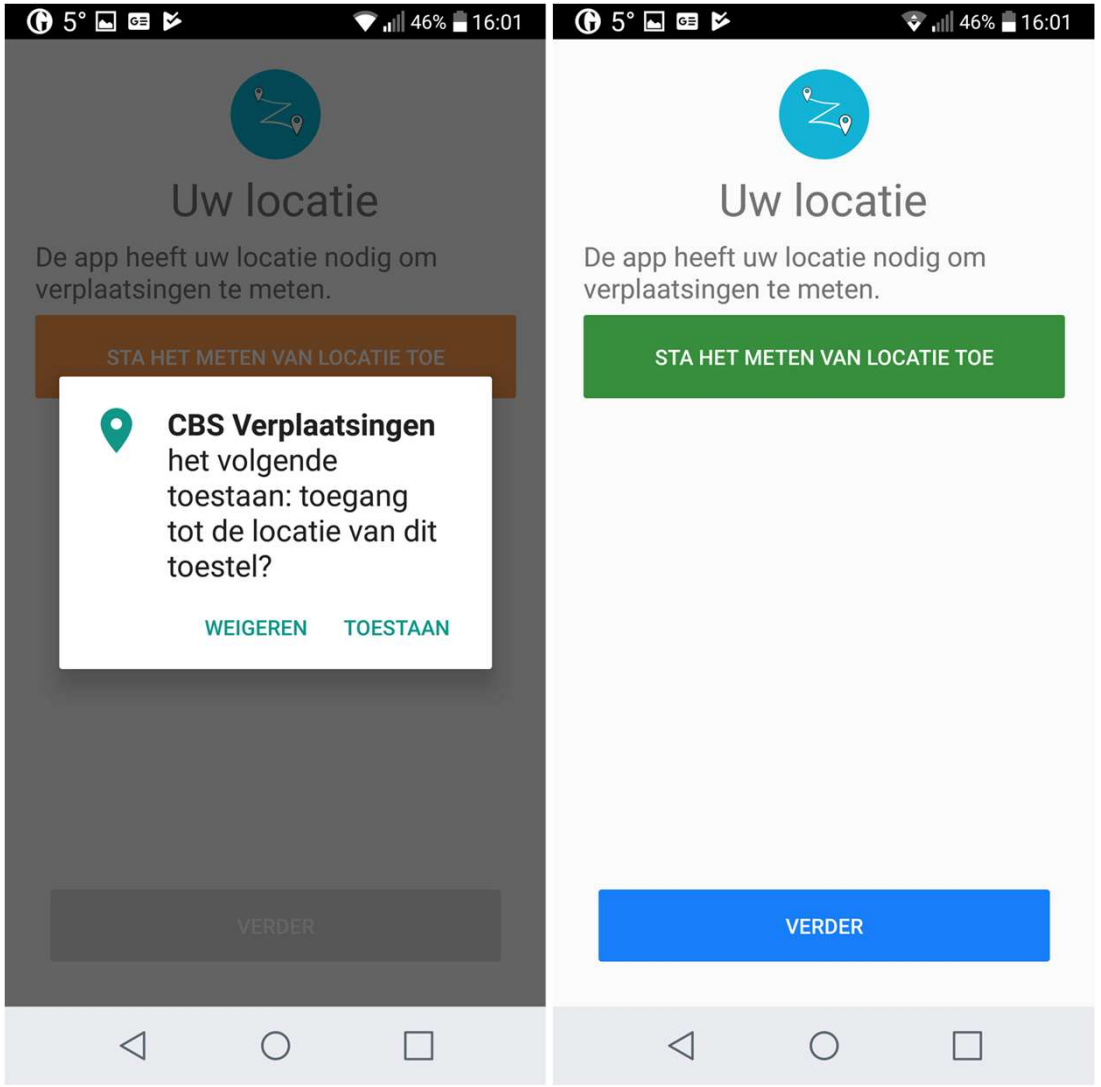
Fieldwork (5)

- Start 31 oktober
- 1. letter
- 2. website
- 3. download app
- 4. welcome
- 5. login



Fieldwork (6)

- Start 31 oktober
- 1. letter
- 2. website
- 3. download app
- 4. welcome
- 5. login
- 6. allow measurement



Does it work?

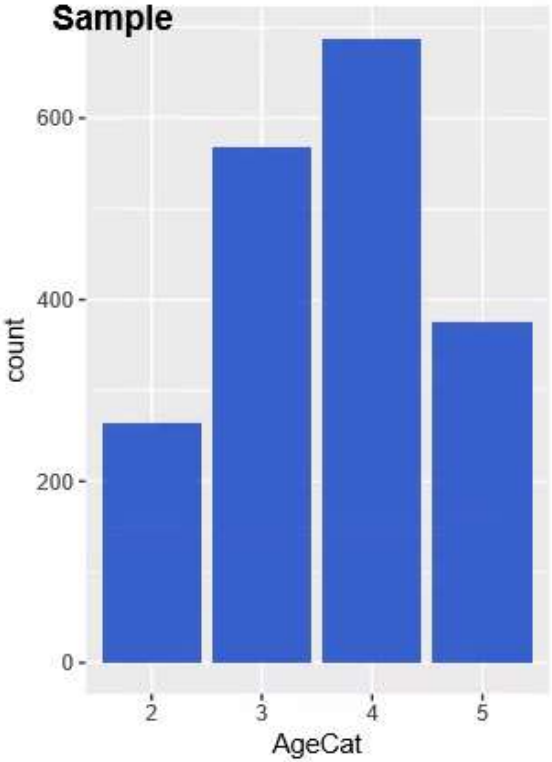
Utrecht University

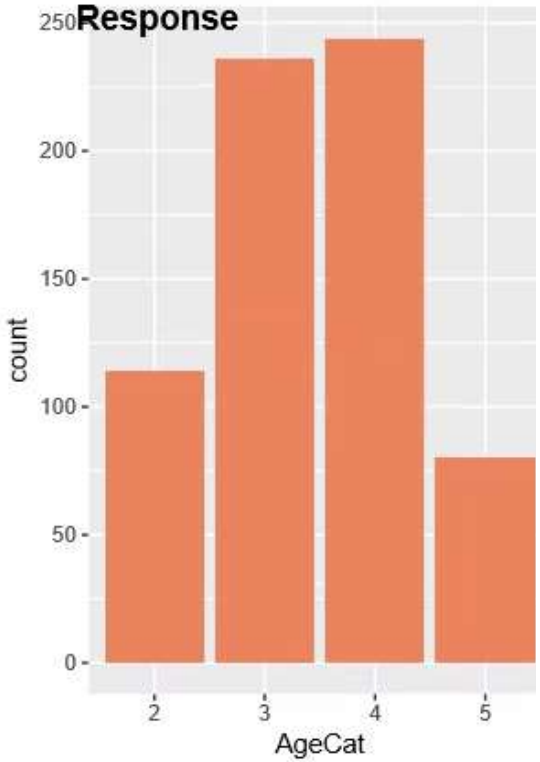
	Sample		incentives		
	Old ODiN sample	New sample	5 + 5 + 5	5 + 0 + 10	5 + 0 + 20
response	422	252	191	231	252
Response Percentage	44,4%	26,5%	30,1%	36,4%	39,7%

421 completes(674 start)

	0	≥7
ODiN	62	257
	15%	61%
New	36	164
	14%	65%
5 + 5 + 5	29	116
	15%	61%
5 + 0 + 10	37	137
	16%	59%
5 + 0 + 20	32	168
	13%	67%

	Stage 1			
	AME	*B*	*se*	*p*
Intercept		-0.975	0.374	**
Sample (ref = New)				
ODiN	0.158	0.769	0.104	***
Incentive (ref = 5-5-5)				
5-10	0.074	0.375	0.128	**
5-20	0.104	0.521	0.127	***
Age (ref = 16-25)				
26-45	-0.124	-0.565	0.185	**
46-65	-0.180	-0.84	0.189	***
>65	-0.264	-1.29	0.231	***
Education (ref = Basisonderwijs)				
Vmbo, avo onderbouw, mbo 1	-0.012	-0.071	0.332	
Havo, vwo, mbo	0.100	0.513	0.31	
Hbo-, wo-bachelor	0.207	0.998	0.327	**
Hbo-, wo-master, doctor	0.200	0.97	0.351	**
Unknown	0.056	0.299	0.315	
Marital status (ref = Married)				
Single	-0.060	-0.302	0.119	*
Origin (ref = Dutch)				
Not-western	-0.110	-0.573	0.209	**
Western	-0.049	-0.244	0.179	
Income (ref = 0-20)				
21-40	-0.097	-0.528	0.225	*
41-60	0.025	0.125	0.208	
61-80	0.072	0.347	0.202	
81-100	0.064	0.31	0.203	
Unknown	-0.025	-0.125	0.562	
Gender (ref = Male)				
Female				





Predicting mode of transport

Utrecht University

predicted	observed									
	E − bike	*bike*	*car*	*metro*	*bus*	*scooter*	*train*	*tram*	*user error*	*walk*
E − bike	70	164	96	0	2	1	1	0	0	22
bike	29	361	51	0	2	0	0	0	1	35
car	8	20	1308	0	8	3	5	0	3	18
metro	0	11	24	13	0	1	7	2	0	9
bus	4	20	199	0	24	1	4	0	1	5
scooter	13	14	195	0	0	22	0	0	0	4
train	2	4	74	0	2	0	142	0	1	10
tram	2	53	35	1	4	0	7	15	2	35
user error	10	54	109	0	1	1	8	2	16	91
walk	10	59	82	0	2	0	1	1	3	671

Table 2: Confusion Matrix for the third model with all the features an no collapsed transport modes yet, accuracy: 62%

Predicting mode of transport(2)

predicted	observed			
	bike collapsed	motorized	public transport	walk
bike collapsed	772	144	8	58
motorized	50	1842	19	30
public transport	12	108	219	18
walk	73	108	8	793

Is it ethical to collect data?

- Open question
- Data are sensitive
- Willingness may change (e.g. Facebook privacy fallout)
- Data privacy rules have been changing (in Europe at least)
- Evolving field

Takeaway: going beyond surveys

- A lot is possible
- Technological challenges (IT-wise)
- Implementation challenges (law, ethics, willingness)
- We are a long way away from actually using this for general populations
- May work in specific sub-populations
  - Just like web surveys evolved
  - E.g. students, employees, ex-prisoners…

Finally

- Questions?
- Vera Toepoel v.toepoel@uu.nl