Assessing the Quality of Digital Behavioral Data for Measuring Smartphone Use

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4th MASS Workshop

Manchester, June 22-23, 2023

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Measuring digital technology use

- Inequalities in smartphone use and skills in general population (*second-level digital divide*; Hargittai, 2002) has implications for social inequalities (Helsper, 2021)
- Most previous digital divide research has relied on surveys for measuring digital technology use and skills
  - But self-reports of behaviors are prone to measurement error
- Digital behavioral data (DBD) are an alternative method for collecting data about digital technology use (Keusch & Kreuter, 2022)
  - Advantages compared to surveys: behaviors can be measured unobtrusively, in a more detailed way, and over a longer period of time

Research questions

1. To what extent do DBD-based measures of smartphone use align with survey-based measures?
   - Usage dimensions: *amount, variety, activites of use* (Blank & Groselj, 2014)

2. How does the alignment vary by sociodemographic characteristics?

3. To what extent do smartphone usage types identified from latent class analysis align between DBD and survey data?

Data and Methods

Sample

Political Identities and News Consumption in Election Times (PINCET; Bach et al., 2023)

- Online panel members in Germany invited to web surveys in Aug-Dec 2021
  - Aged 18+, resident in Germany, eligible to vote in 2021 German federal election
  - Quotas for gender, age, and state
- N=1,204 smartphone users completed the wave 1 survey and had downloaded the research app on their smartphone
  - Information about app use (name + date, time, duration of use) and website visits (URL, domain + date, time, duration of visit)
- For each participant, we use the app data collected prior to their wave 1 interview
  - Median duration: 47 days (min: 1 day, max: 55 days)

Data and Methods

Survey-based measures

- *Amount of use*: time spent using the smartphone on ordinary day (hours, mins)
- *Activities of use*: each coded as yes vs. no

  (1) Making and receiving phone calls, (2) Using messenger services, (3) Visiting websites, (4) Sending and/or reading emails, (5) Taking photos, (6) Using social media, (7) Shopping, (8) Online banking, (9) Using location-based apps, (10) Playing games, (11) Listening to music or watching videos, (12) Health and/or fitness tracking,

  (13) Reading, listening, or watching the news
- *Variety of use*: number of different activities summed up (min: 1, max: 13)

Data and Methods

DBD-based measures

- *Amount of use*: time spent on all apps during the data collection period, divided by the number of days for which smartphone was tracked
- *Activities of use*: each coded as yes vs. no
  - Classification of apps into activities:
    (1) App store categories were used as the starting point
    (2) Categories were refined through manual coding
- *Variety of use*: number of different activities summed up (min: 0, max: 13)

Data and Methods

Alignment measures (Araujo et al., 2017)

Absolute error

- Continuous: absolute difference between DBD and survey
- Categorial: 1 if different, 0 if not different

Underreporting: behavior observed in DBD, not in survey

- Continuous: difference between DBD and survey if underreported
- Categorial: 1 if underreported, 0 if not underreported

Overreporting: behavior observed in survey, not in DBD

- Continuous: difference between DBD and survey if overreported
- Categorial: 1 if overreported, 0 if not overreported

Results

1. To what extent do DBD-based measures of smartphone use align with survey-based measures?

	Absolute error	Underreporting	Overreporting
Amount of use	min	min	min
Mean	157	20	137
Variety of use	#	#	#
Mean	3	1	2

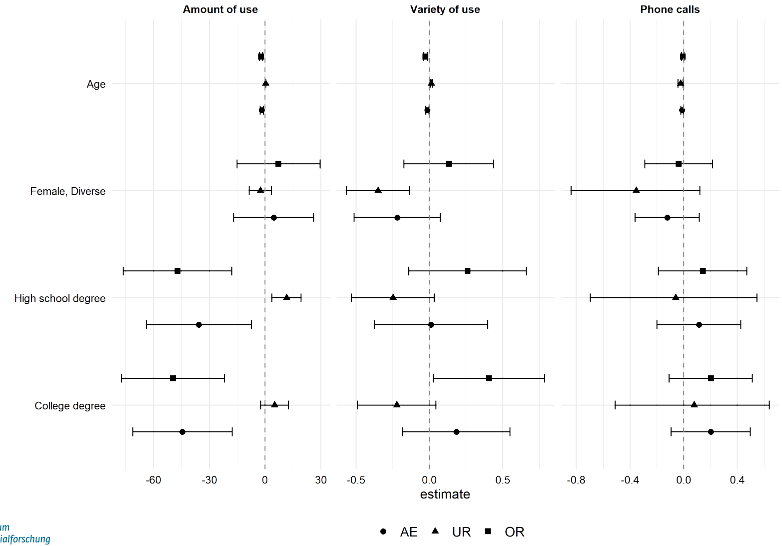
Results

1. To what extent do DBD-based measures of smartphone use align with survey-based measures?

	Absolute error	Underreporting	Overreporting
Activities of use	%	%	%
Browsing websites	68	2	66
News	60	1	60
Health or fitness	47	36	11
Shopping	40	32	8
GPS	40	18	22
Music or videos	39	32	8
Photos	35	11	24
Phone calls	35	6	29
Online banking	32	16	16
Games	29	17	12
Emails	23	11	13
Social media	22	14	9
Messenger services	14	8	6

Results

2. How does the alignment vary by sociodemographic characteristics?



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Results

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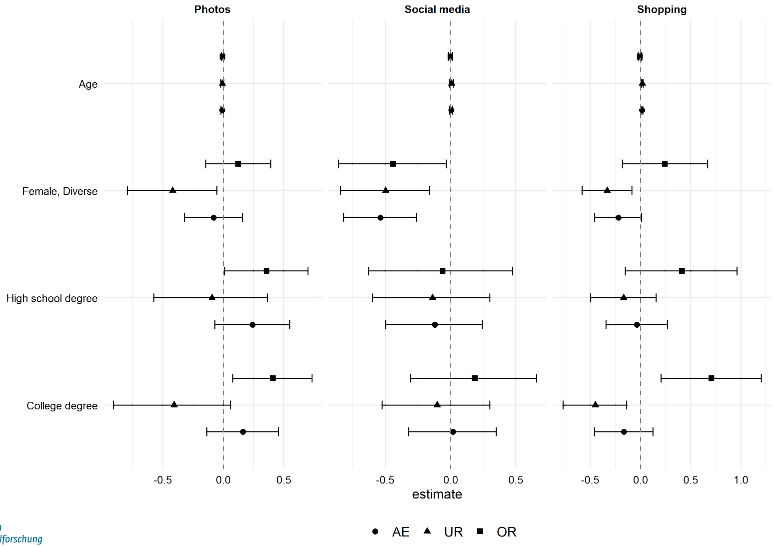

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Results

3. To what extent do smartphone usage types align between DBD and survey data?

Survey	Advanced users	Intermediate users	Basic users
%	53	34	13
Amount of use	Large	Medium	Small
Variety of use	Large	Small	Small
Activities of use	Most	Several	News, phone calls, messenger, photos

DBD	Advanced users	Social media users	Phone call users	Basic users
%	56	16	16	12
Amount of use	Large	Medium	Medium	Small
Variety of use	Large	Small	Small	Small
Activities of use	Most	Messenger, social media, shopping + others	Messenger, phone calls, photos + others	Messenger, emails

Results

3. To what extent do smartphone usage types align between DBD and survey data?

%	Survey		
DBD	Advanced users	Intermediate users	Basic users
Advanced users	32	19	5
Social media users	11	4	1
Phone call users	5	7	4
Basic users	5	5	2

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Key takeaways

1. To what extent do DBD-based measures align with survey-based measures?
   - *Amount of use*: considerable overreporting in the survey
   - *Variety of use*: close alignment
   - *Activities of use*: alignment differs by type of activity
2. How does the alignment vary by sociodemographic characteristics?
   - Alignment is systematically related to age, gender, and educational attainment
3. To what extent do smartphone usage types align between DBD and survey data?
   - Similar typologies, but more nuanced in the DBD
   - Classes have similar size, but small overlap on individual level

Discussion

- Findings in line with previous research
  - Correlations between self-reported and tracked measures are generally small to moderate (e.g., Parry et al., 2021)
- DBD and survey data might better measure different aspects of smartphone use
  - DBD better at measuring *amount of use*
  - DBD and survey data equally suitable for measuring *variety of use*
  - Survey data better for *activities* carried out across multiple apps (e.g., news consumption, watching videos)
  - DBD better for *activities* carried out within distinct apps (e.g., calls, taking photos)

Any questions?

Appendix

Alignment measures (Araujo et al., 2017)

Absolute error

- *Amount* and *variety of use* $= |\text{Survey} - \text{DBD}|$
- *Activities of use* $= \begin{cases} 1 & \text{if different} \\ 0 & \text{if not different} \end{cases}$

Appendix

Alignment measures (Araujo et al., 2017)

Underreporting: behavior observed in DBD, not in survey

- *Amount* and *variety of use* $= \begin{cases} \text{DBD} - \text{Survey} & \text{if underreported} \\ 0 & \text{if not different or overreported} \end{cases}$
- *Activities of use* $= \begin{cases} 1 & \text{if underreported} \\ 0 & \text{if not different or overreported} \end{cases}$

Appendix

Alignment measures (Araujo et al., 2017)

Overreporting: behavior observed in survey, not in DBD

- $\textit{Amount}$ and $\textit{variety of use} = \begin{cases} \text{Survey} - \text{DBD} & \text{if overreported} \\ 0 & \text{if not different or underreported} \end{cases}$
- $\textit{Activities of use} = \begin{cases} 1 & \text{if overreported} \\ 0 & \text{if not different or underreported} \end{cases}$

Appendix

Latent class analysis (LCA)

- To create typologies of smartphone use, LCAs were conducted separately for the DBD and survey data
- Participants assigned to classes based on their similarity in the indicator variables
  - *Amount* and Variety of use: coded as below median vs. equal or above median
  - *Variety of use*: 13 activities coded as yes vs. no
- Number of classes were varied from 2 to 10
- Best-fitting model selected based on LL, AIC, BIC