Privacy Concerns Go Hand in Hand with Lack of Knowledge: The Case of the German Corona-Warn-App

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Introduction

- Contact Tracing App in Germany
- Functionality
  - Contact tracing
  - Registration of positive tests
- Long discussion between experts
  - Centralised / **decentralised**
  - PEPP-PT / **DP3T**
- Mixed media echo

- Meanwhile 30 Million downloads
- Meanwhile new functions
  - Vaccination certificates
  - Statistics
  - Event check-ins

Motivation

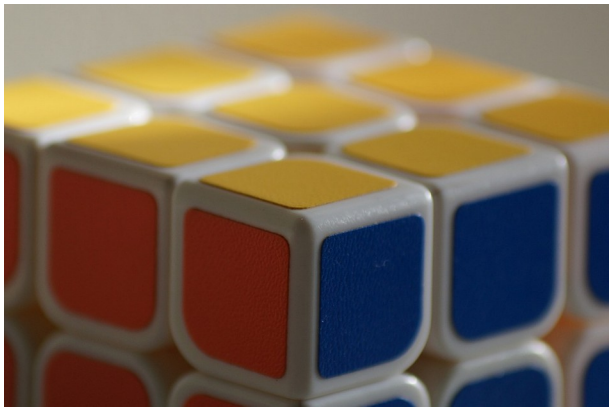
- CWA designed with privacy in mind
- A lot of related work on privacy concerns
  - On contract tracing apps
  - Some on the German app
  - Many of it cover hypothetical scenarios or usage intention

- Role of knowledge on privacy concerns

  → Hypothesis: Knowledge about the CWA reduces privacy concerns
- Special situation since in general, e.g. for smartphones not clear
- Investigation of demographic effects

Methodology

- Questionnaire
  - Privacy Concerns (based on Gu et al.)
  - Knowledge about CWA
    - Based on official material from the CWA Consortium, Robert-Koch Institute and the German Government
- Data Collection (N=1752)
  - Sampled for 3 dimensions
    - Age (EUROSTAT2018)
    - Gender (EUROSTAT2018)
    - CWA-Users / non-Users
  - Statistically small but significant differences
    - Income
    - Education
    - Experience in Smartphones



Demographics	N	%
Age		
18-29 years	371	21.17%
30-39 years	316	18.04%
40-49 years	329	18.78%
50-59 years	431	24.60%
60 years and older	305	17.41%
Net income		
500€- 1000€	160	9.13%
1000€- 2000€	402	22.95%
2000€- 3000€	404	23.06%
3000€- 4000€	314	17.92%
More than 4000€	292	16.67%
Prefer not to say	180	10.27%

Demographics	N	%
Gender		
Female	894	51.03%
Males	853	48.69%
Diverse	4	0.23%
Prefer not to say	1	0.06%
Education		
1 No degree	8	0.46%
2 Secondary school	187	10.67%
3 Secondary school^{+}	574	32.76%
4 A levels	430	24.54%
5 Bachelor's degree	240	13.70%
6 Master's degree	285	16.27%
7 Doctorate	28	1.60%

$^{+}$5 GCSEs at grade C and above

Gu, J., Xu, Y.C., Xu, H., Zhang, C., Ling, H.: Privacy concerns for mobile app download: An elaboration likelihood model perspective. Decision Support Systems 94, 19–28 (2017)

Knowledge

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Data Collection

1. The Corona-Warn-App ...

– collects location data and shares it with local health departments.

+ does not collect location data.

– collects location data and shares it with the Robert Koch Institute.

– collects location data and shares it with the Corona-Warn-App operators.

Regulation

3. The installation of the Corona-Warn-App ...

+ is voluntary.

– is required by law for all persons who own an appropriate smartphone.

– is required by law for workers who cannot work in a home office.

– is required by law for persons with regular contact with more than 10 people.

Function

2. The Corona-Warn-App ...

+ records risk encounters in public spaces.

– is a substitute for the official reporting channels required by the Infection Protection Act.

+ alerts users to encounters with positive-tested persons within the past 14 days.

– warns the user of positive-tested persons in the vicinity.

Positive Test Results

4. The registration of a positive SARS-CoV-2 test result in the app is …

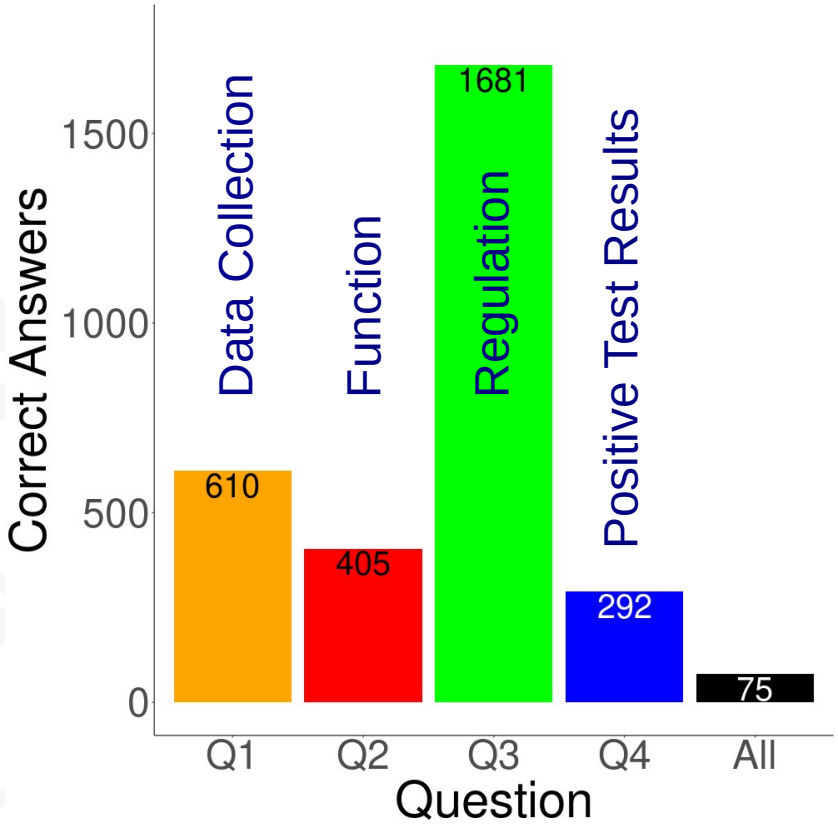
+ done by the user via QR code or TeleTAN.

– transmitted automatically by the test laboratory.

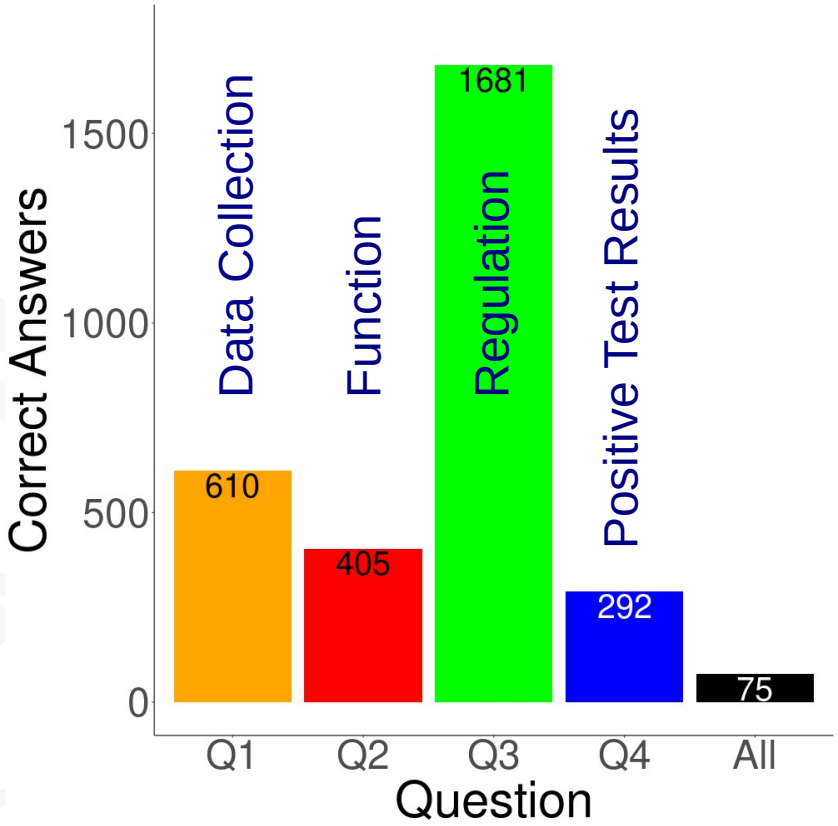
– automatically transmitted to the Corona-Warn-App server.

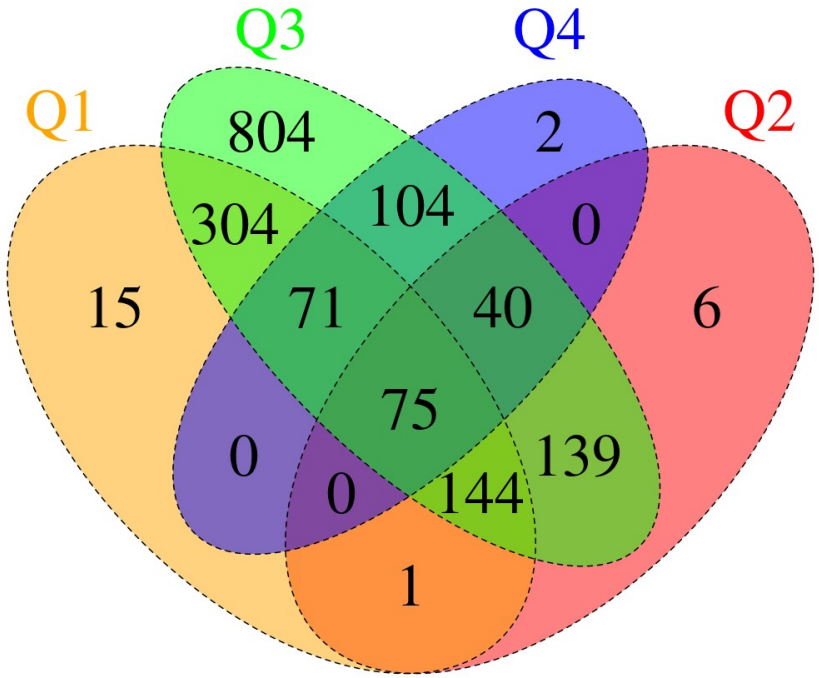
+ only transmitted to the Corona-Warn-App server after the user gave consent.

Knowledge: Results

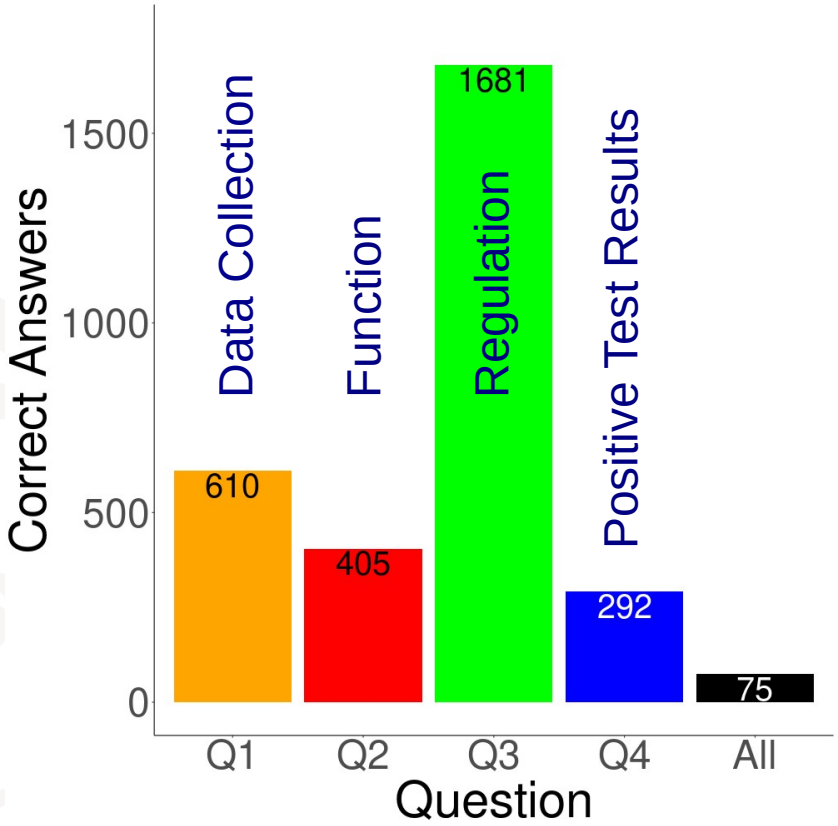


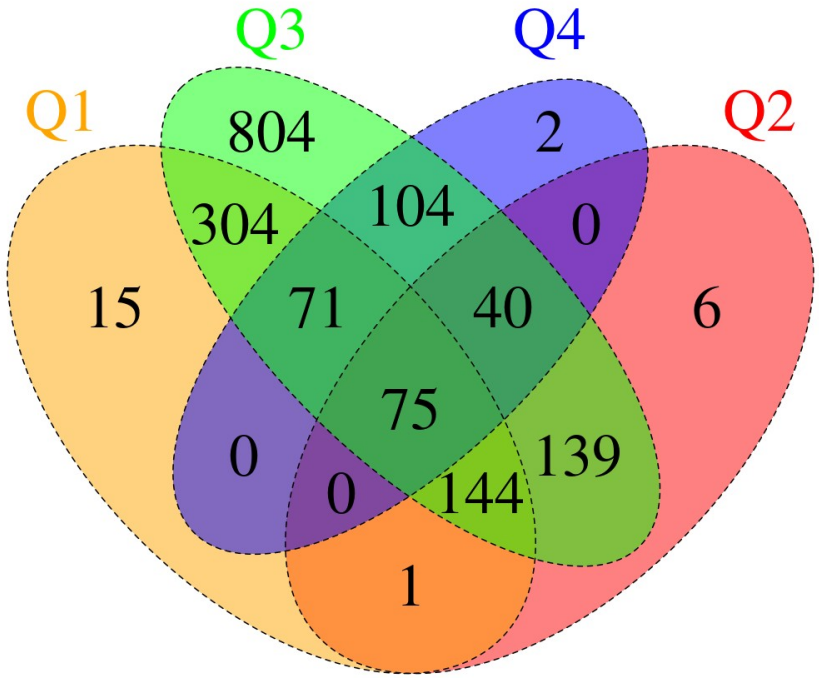
Knowledge: Results

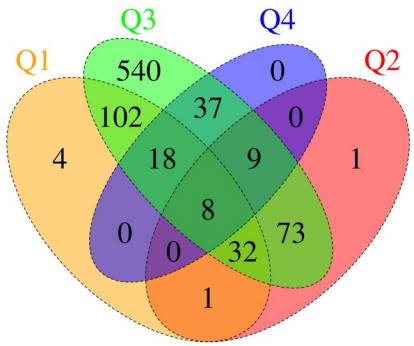




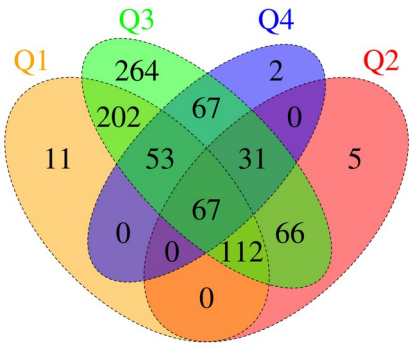
Knowledge: Results





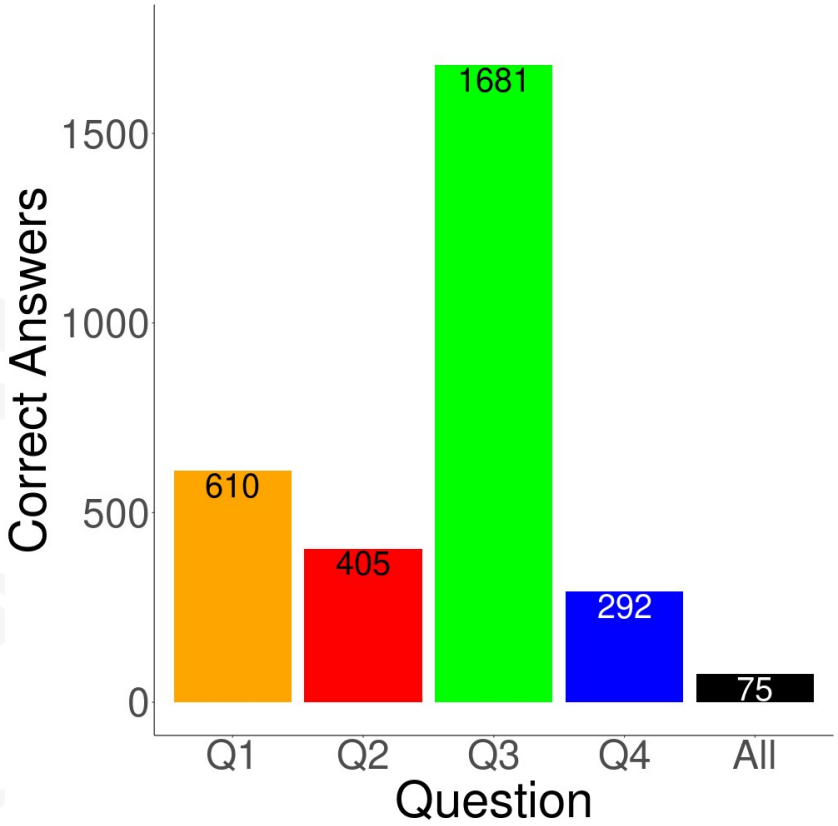


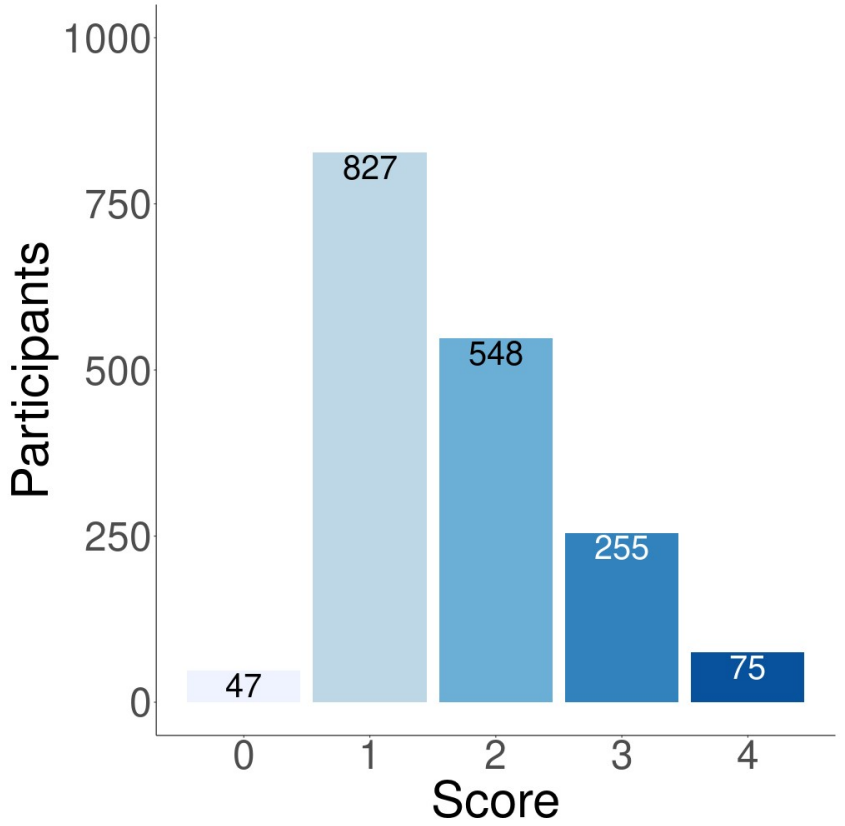
non-users



CWA users

Knowledge: Score





Score: Distribution

Table 2: Score for Binary Groups, Levene's Test and Wilcoxon Rank Sum

Variable	Means	Levene's Test	Wilcoxon Rank Sum
CWA	*non-users:* 1.38 *users:* 2.02	$F(1,1750)=33.45^{***}$	$W=234994^{***}$ r=-0.36
GDR	*females:* 1.66 *males:* 1.70	$F(1,1745)=6.86^{**}$	$W=365109^{+}$ r=-0.04
OS	*Android:* 1.68 *iOS:* 1.80	$F(1,1733)=2.69$	$W=263020^{*}$ r=-0.06

Significance codes: $^{***} < 0.001$ $^{**} < 0.01$ $^{*} < 0.05$ $^{+} < 0.1$

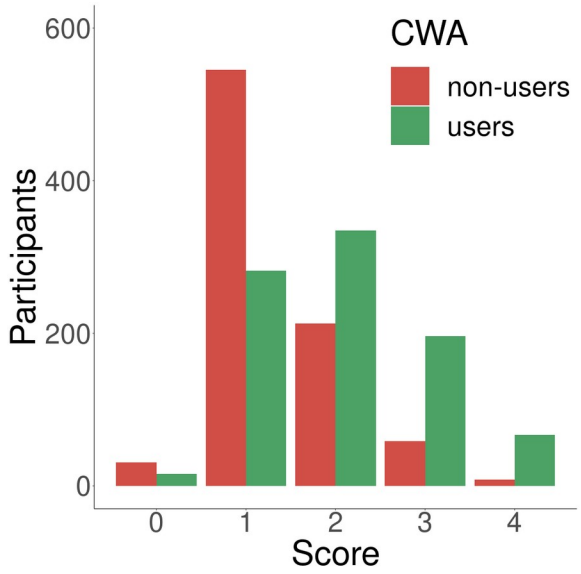


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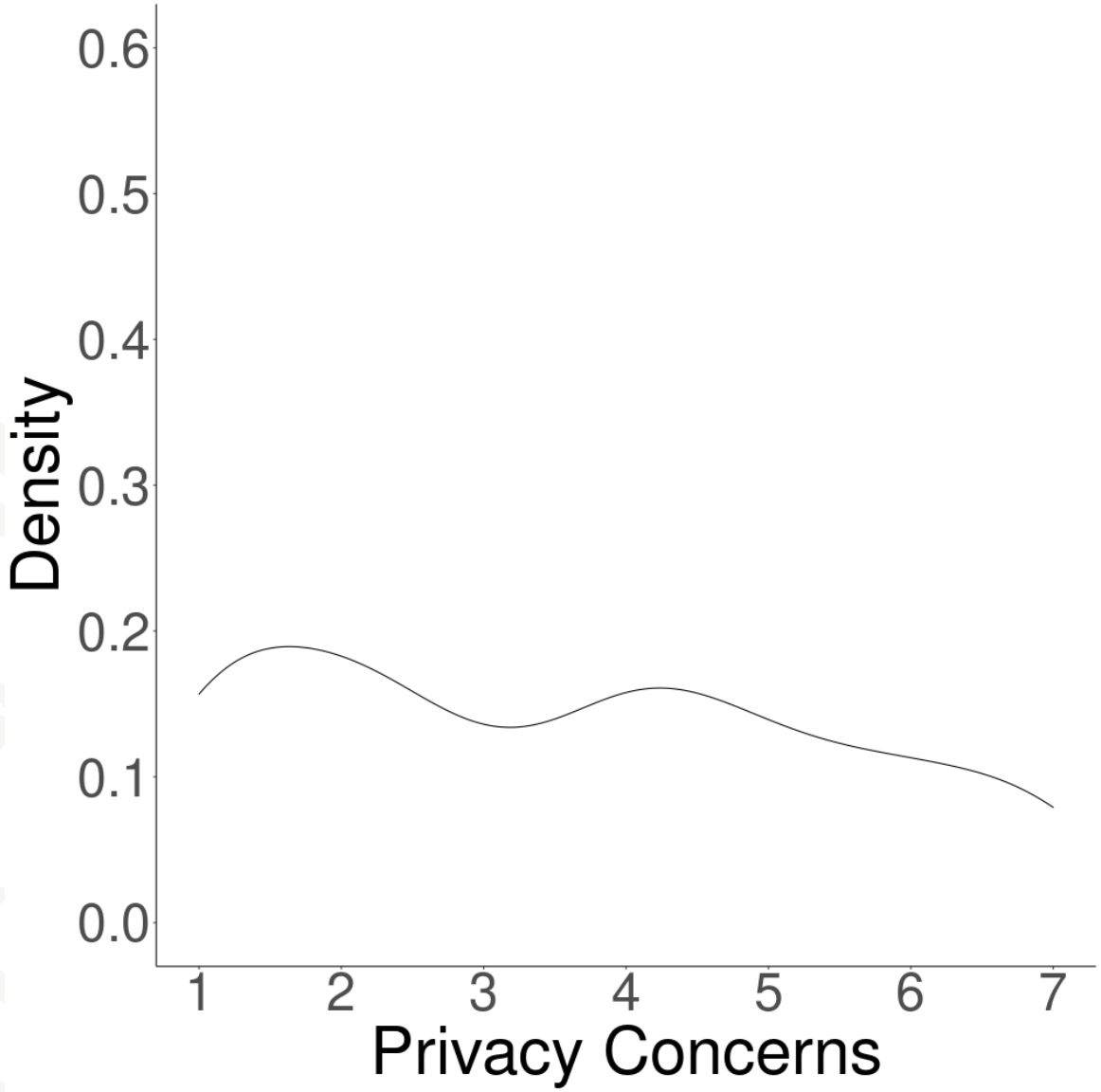
Table 3: Score for Categorical Groups and Jonckheere Terpstra Test (JT)

Variable	Means							JT
Age	*18-29:* 1.797	*30-39:* 1.743	*40-49:* 1.739	*50-59:* 1.694	*60-99:* 1.534			572754 $\downarrow^{***}$
Income	*.5k-1k:* 1.781	*1k-2k:* 1.614	*2k-3k:* 1.688	*3k-4k:* 1.748	*>4k:* 1.836			465749 $\uparrow^{*}$
Educat.	*1:* 1.13	*2:* 1.35	*3:* 1.57	*4:* 1.85	*5:* 1.83	*6:* 1.88	*7:* 1.96	682572 $\uparrow^{***}$

Significance codes: $^{***} < 0.001$ $^{**} < 0.01$ $^{*} < 0.05$ $^{+} < 0.1$

Privacy Concerns: Distribution



Privacy Concerns: Distribution

Table 4: Concerns for Binary Groups, Levene's Test and Wilcoxon Rank Sum

Variable	Means	Levene's test	Wilcoxon rank sum
CWA	*non-users:* 4.64 *users:* 2.57	$F(1,1750)=11.5^{***}$	$W=622466^{***}$ r=-0.54
GDR	*females:* 3.64 *males:* 3.52	$F(1,1745)=3.82^{+}$	W=397724 r=-0.04
OS	*Android:* 3.66 *iOS:* 3.31	$F(1,1733)=1.28$	$W=312620^{**}$ r=-0.08

Significance codes: $^{***} < 0.001$ $^{**} < 0.01$ $^{*} < 0.05$ $^{+} < 0.1$

Privacy Concerns: Distribution

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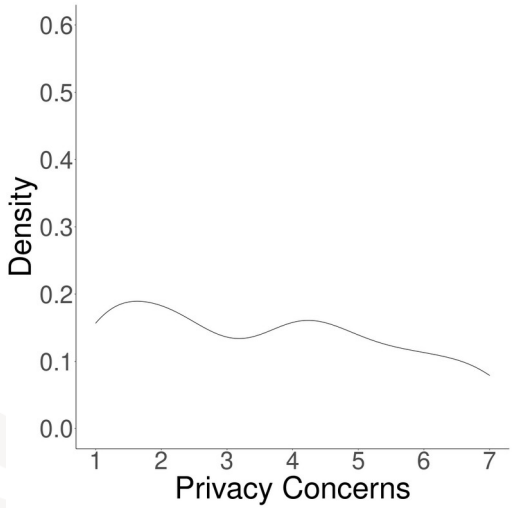
Significance codes: $^{***} < 0.001$ $^{**} < 0.01$ $^{*} < 0.05$ $^{+} < 0.1$

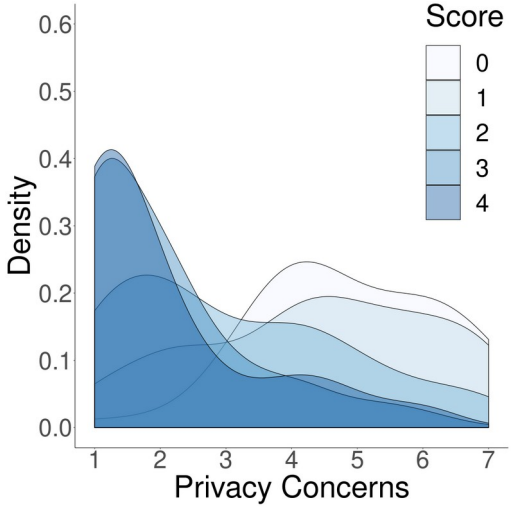
Table 5: Concerns for Categorical Groups and Jonckheere Terpstra Test (JT)

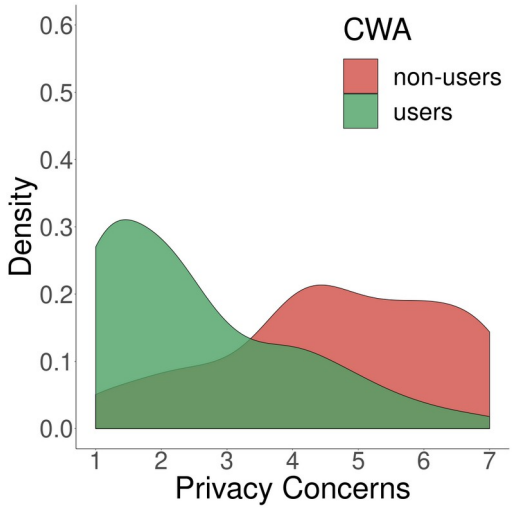
Variable	Means							JT
Age	*18-29:* 3.583	*30-39:* 3.730	*40-49:* 3.551	*50-59:* 3.619	*60-99:* 3.392			594366 $\downarrow^{+}$
Income	*.5k-1k:* 3.478	*1k-2k:* 3.772	*2k-3k:* 3.710	*3k-4k:* 3.487	*>4k:* 3.046			523662 $\downarrow^{***}$
Educat.	*1:* 4.60	*2:* 4.06	*3:* 3.82	*4:* 3.43	*5:* 3.42	*6:* 3.21	*7:* 2.68	520337 $\downarrow^{***}$

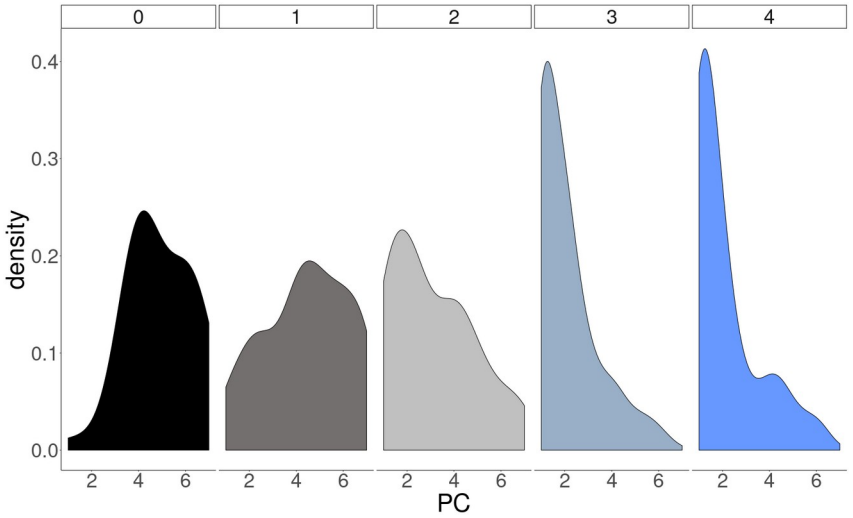
Significance codes: $^{***} < 0.001$ $^{**} < 0.01$ $^{*} < 0.05$ $^{+} < 0.1$

PC vs. CWA-Usage + Score









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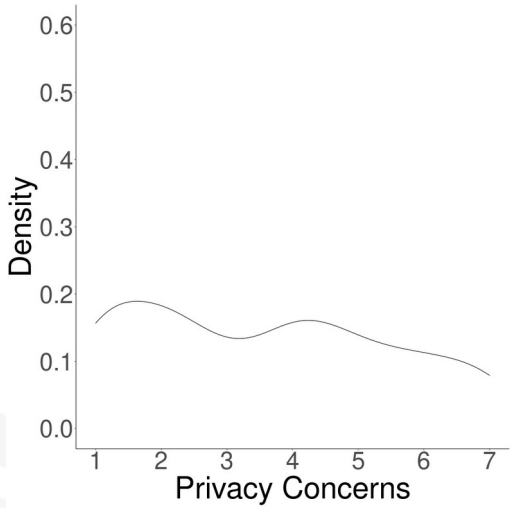
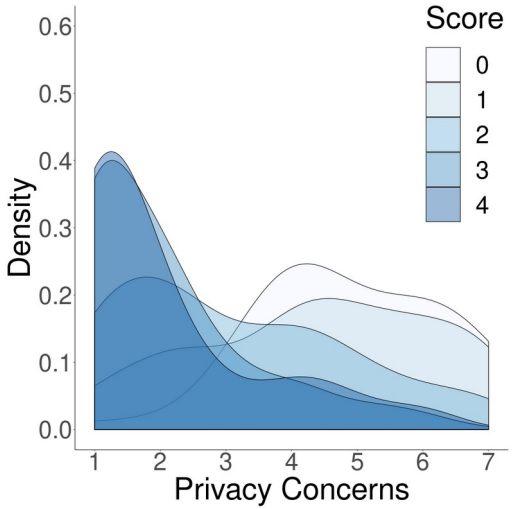
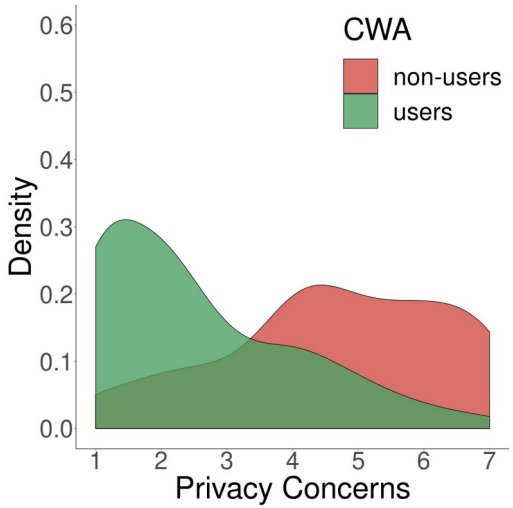
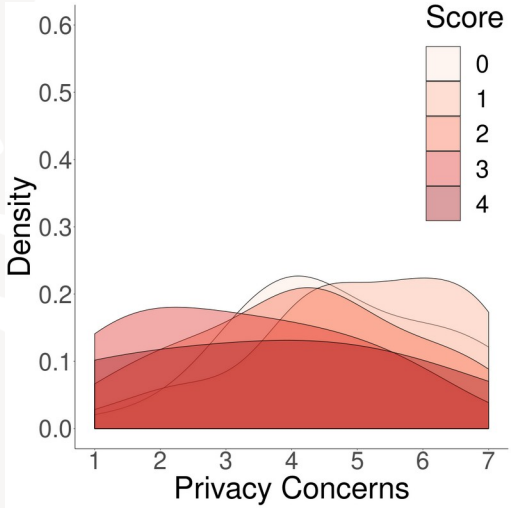
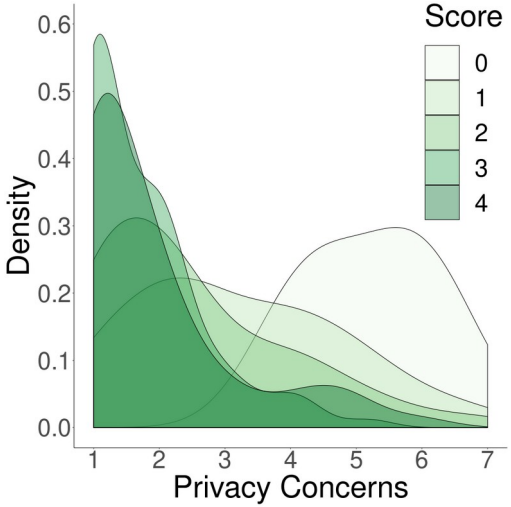






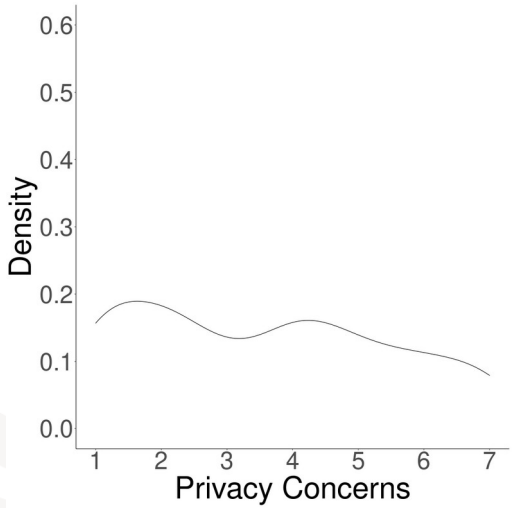


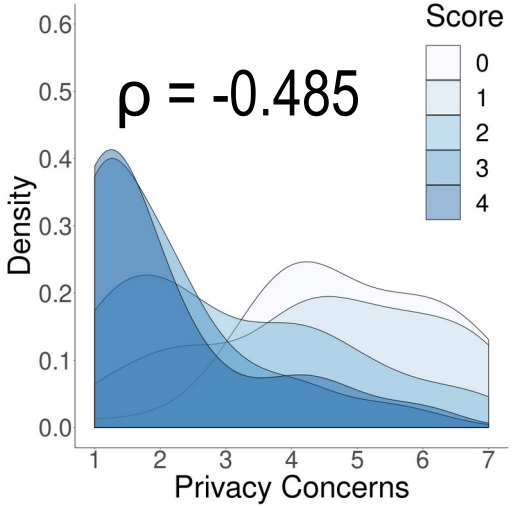
non-users

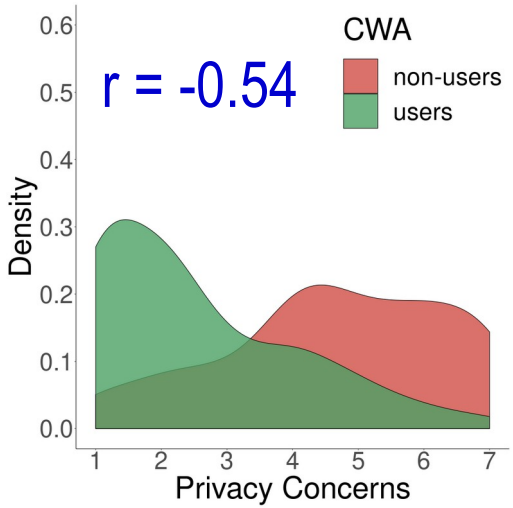


CWA users

PC vs. CWA-Usage + Score

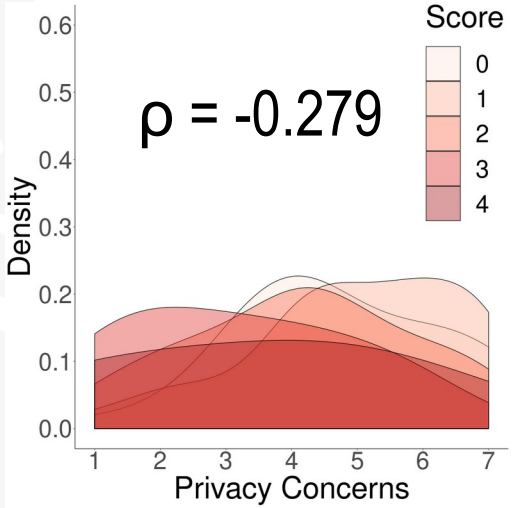




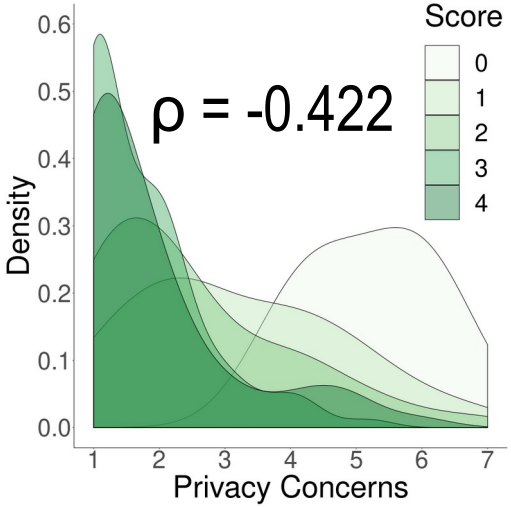


Spearman's rank correlation

Wilcoxon Rank Sum



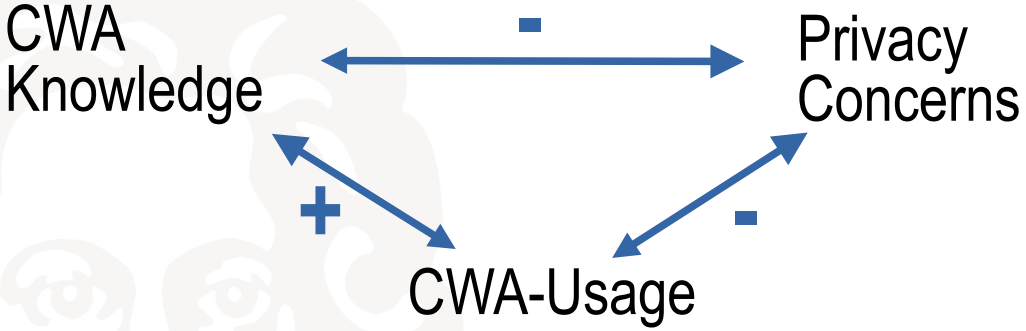
non-users



CWA users

Discussion & Limitations

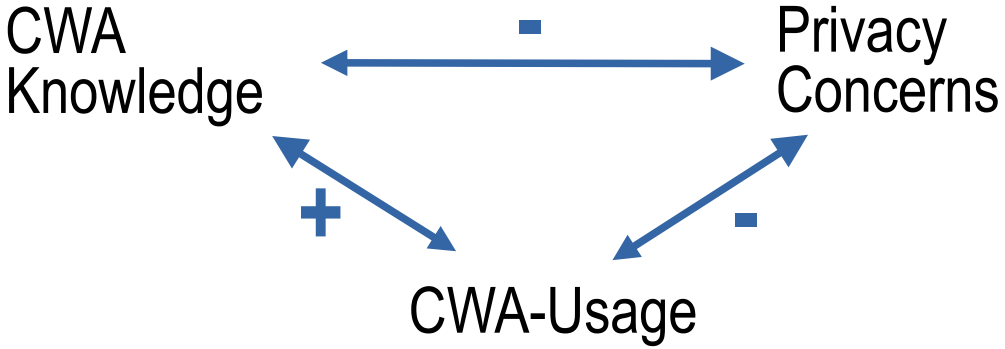
- CWA Knowledge (+ education & income, - age, / gender & experience)
  - Novel findings about knowledge, general research on demographics of digital literacy inconclusive
- Privacy Concerns (- education & income, / age & gender & experience)
  - Literature supports findings on education, income and gender, but contradicts gender and age
- Knowledge vs. Privacy Concerns vs. CWA-Usage
  - Privacy concerns major obstacle for adoption



- Limitations
  - Results can not easily be generalized for other contact tracing apps
  - Based on self-reports
  - Potential biases due to social desirability, mood, translation of the questionnaire

Conclusion & Future Work

- Important to learn more about users to be prepared for the next pandemic
- Establish causality
- Education might play an important role



- Investigate other factors
  - Trust (into health system)
  - Perceived Benefits
  - Political Opinion
  - Social influence

Contact

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