Understanding The Role of Incentives in Consumer Privacy Preferences

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Junhui Li (CS)

Privacy
Preference

Incentive

THE WALL STREET JOURNAL.

Facebook in Privacy Breach

Top-Ranked Applications Transmit Personal IDs, a Journal Investigation Finds

- More than 540 million records
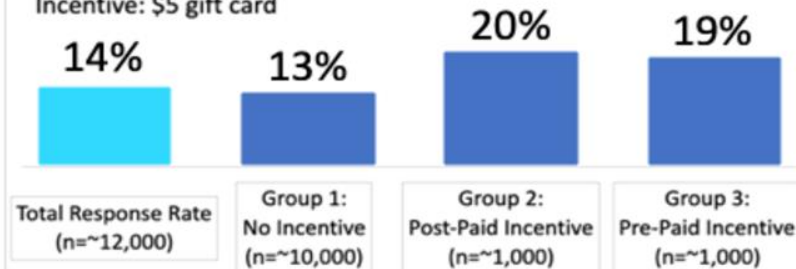- Up to 87 million people

People care about privacy.

#OurPrivacyMatters
vpn.com/facebook

Web Survey Response Rates
(Based on a large US university's alumni survey)

marketing charts

Incentive: $5 gift card

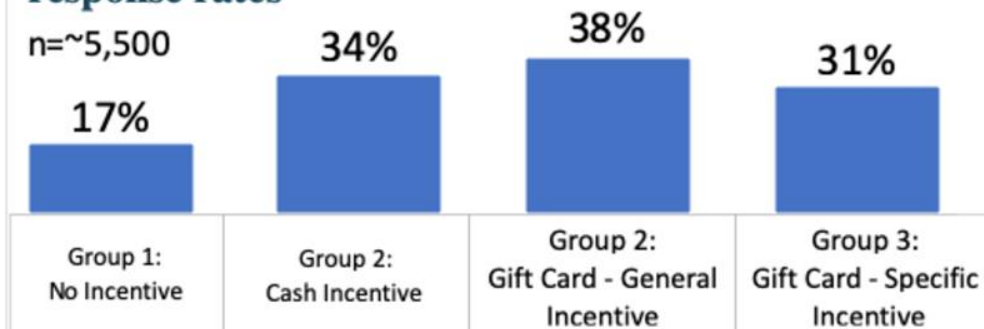| Total Response Rate (n=~12,000)	Group 1: No Incentive (n=~10,000)	Group 2: Post-Paid Incentive (n=~1,000)	Group 3: Pre-Paid Incentive (n=~1,000)
14%	13%	20%	19%

Data come from Gallup, published on MarketingCharts.com in January 2018

People care about incentives.

**National Survey of Student Engagement (NSSE) response rates**

n=~5,500

Group 1: No Incentive	Group 2: Cash Incentive	Group 2: Gift Card - General Incentive	Group 3: Gift Card - Specific Incentive
17%	34%	38%	31%

Data come from "Survey Lottery Incentives and Institutional Response Rates: An Exploratory Analysis" in May 2014

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Total Response Rate (n=~12,000)	Group 1: No Incentive (n=~10,000)	Group 2: Post-Paid Incentive (n=~1,000)	Group 3: Pre-Paid Incentive (n=~1,000)

Data come from Gallup, published on MarketingCharts.com in January 2018

People care about incentives.

Are incentives powerful enough
to change the privacy mindset of people?

#OurPrivacyMatters
vpn.com/facebook

17%

Group 1: No Incentive	Group 2: Cash Incentive	Group 2: Gift Card - General Incentive	Group 3: Gift Card - Specific Incentive

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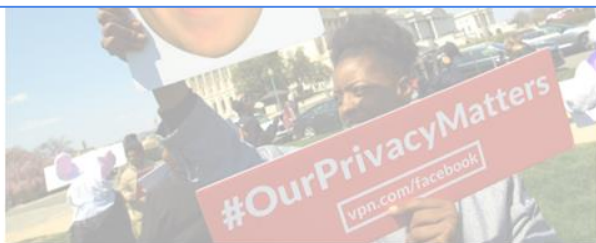
Does Privacy Counseling Impact Privacy Trading Preferences in Society?

Counseling

Incentive

Privacy Awareness Training

Disadvantages and Impact of Sharing Data
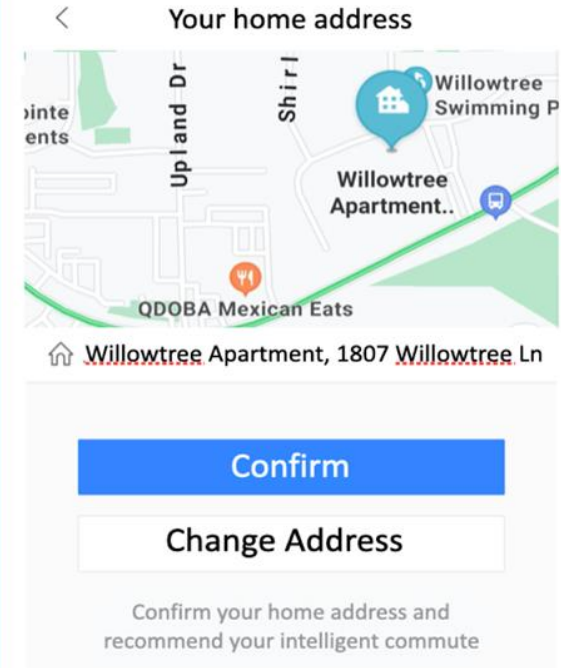

Spam messages and emails including Ads

Spam Emails Data
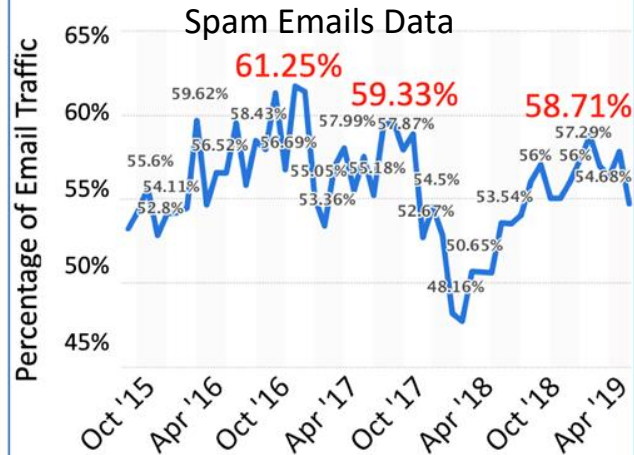
Scam phone calls

Scam Calls Stats for 2019
- Amount lost: $142,898,217
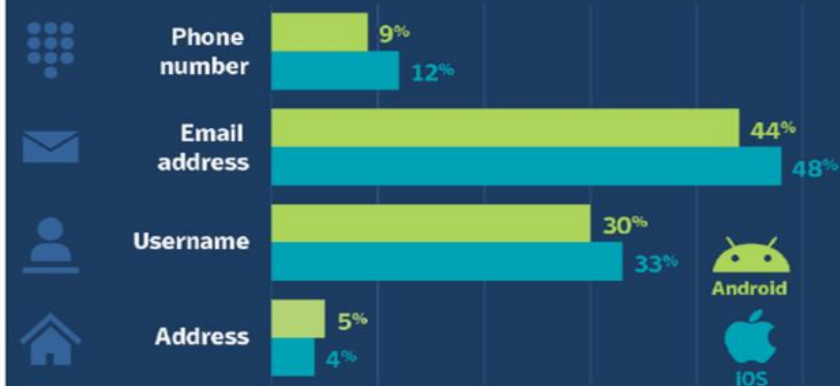- Number of reports: 167,802
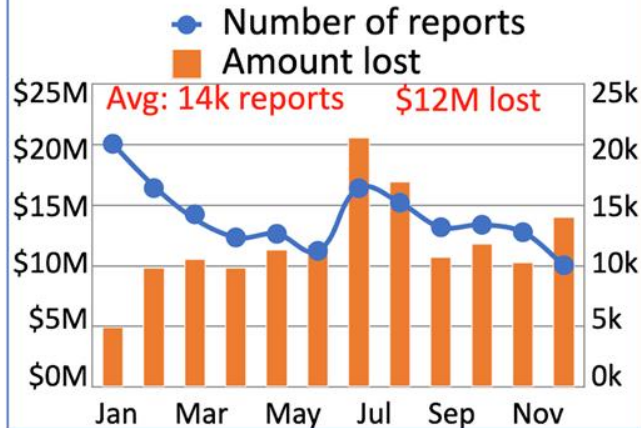
Location privacy breach

Your home address

Willowtree Apartment, 1807 Willowtree Ln

Confirm

Change Address

Confirm your home address and recommend your intelligent commute

Risky Permissions on Phones

Analysis of top 100 apps on Google Play and iTunes*

Personally identifiable information (PII) shared with apps

		Android	iOS
Phone number		9%	12%
Email address		44%	48%
Username		30%	33%
Address		5%	4%

Risky permissions breakdown

	Android	iOS
Track location	45%	25%
Access camera	46%	25%
Record audio	25%	9%
Read phone call log	10%	Not available on iOS
Read SMS messages	15%	Not available on iOS

Data come from Symantec
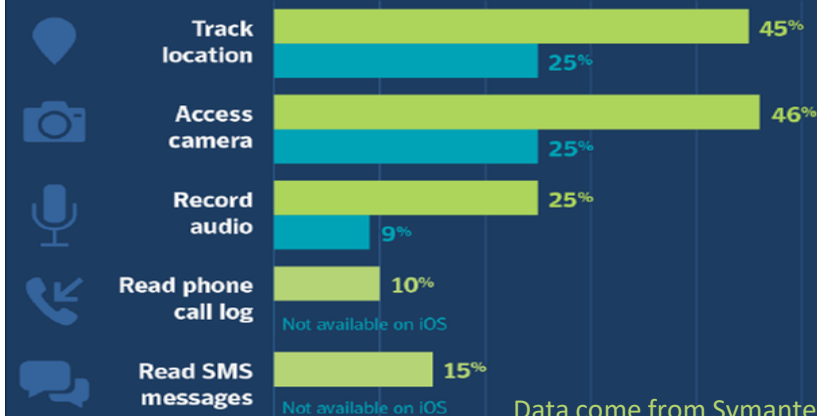
Are all permissions necessary?

Storage	
Allows apps to access photos, media, and files on your device.	
All — 9 apps have this permission	⊘
Sogou Keyboard	⊘
百度地图 Baidu Maps	⊘
Teambition	⬤
Uber	⊘
WeChat	⬤
WhatsApp	⬤
WPS Office	⬤
Maps	⊘
Zoom	⊘

Location	
Allows apps to access this device's location.	
All — 3 apps have this permission	⊘
百度地图 Baidu Maps	⬤
Teambition	⊘
Transit	⬤
Uber	⊘
WeChat	⊘
WhatsApp	⊘
WPS Office	⊘
Maps	⬤
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WeChat	⬤
WhatsApp	⬤
WPS Office	⬤
Maps	⬤
Zoom	⬤

More Secure with iPhone

Hours People Spent on Mobile Per Day

Age Group	Hours
18-24	5h 18m
25-34	5h 6m
35-44	4h 51m
45-54	3h 38m
55+	3h 3m

Risky permissions

Percentage of apps that request risky permissions by operating system

Android 89%
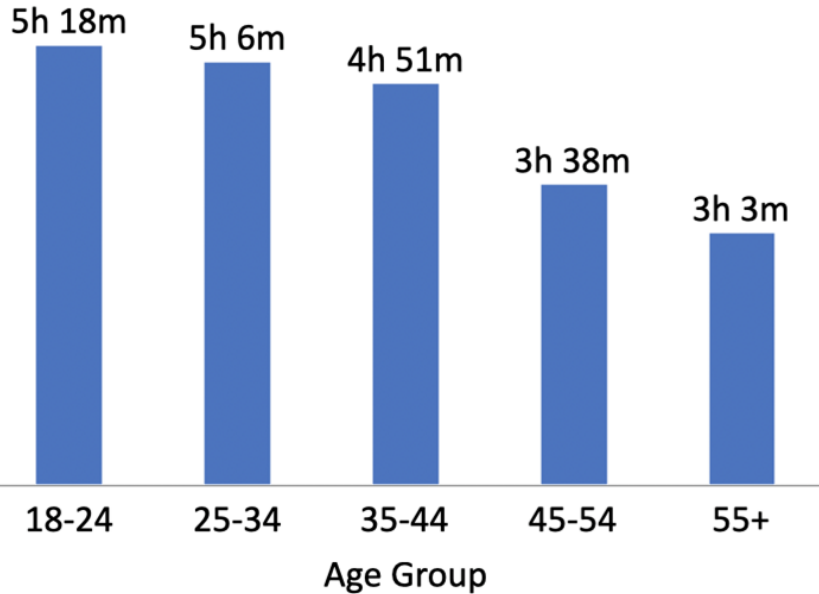
iPhone 39%

iPhone 8	iPhone 11	iPhone SE (2nd generation)
Starting at $699	Starting at $699	Starting at $399
Buy	Buy	Buy

How to protect your personal information?

Read the privacy policy

Don't sign into apps with social networking site account

Only download from trusted sources
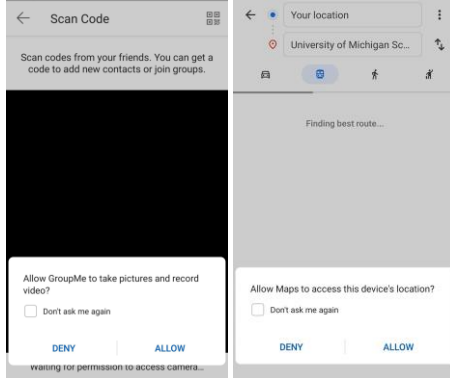
Check app permissions

Keep apps update

Use VPN for public Wi-Fi networks

How to protect your personal information?

Google Privacy

Read the priva

Google Privacy & Terms

Privacy controls

Activity Controls
Decide what types of activity you'd like saved in your account. For example, you can turn on Location History if you want traffic predictions for your daily commute, or you can save your YouTube Watch History to get better video suggestions.
Go to Activity Controls

Ad settings
Manage your preferences about the ads shown to you on Google and on sites and apps that partner with Google to show ads. You can modify your interests, choose whether your personal information is used to make ads more relevant to you, and turn on or off certain advertising services.
Go to Ad Settings

Shared endorsements
Choose whether your name and photo appear next to your activity, like reviews and recommendations, that appear in ads.
Go to Shared Endorsements

Information you share
If you're a G Suite user, control whom you share information with through your account on Google+.
Go to Information You Share

Read the privacy policy

y download
rusted sources

Check app per

se VPN for
Wi-Fi networks

How to protect your personal information?

Read the priv...
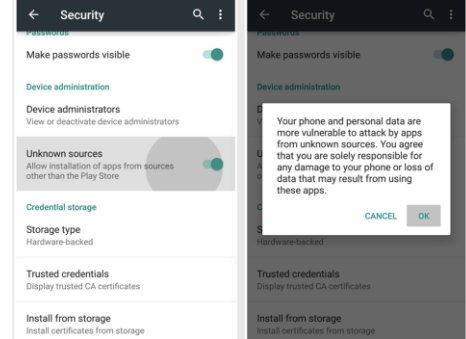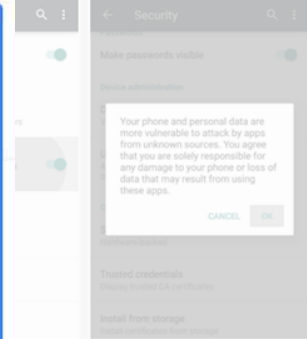
Check app p...
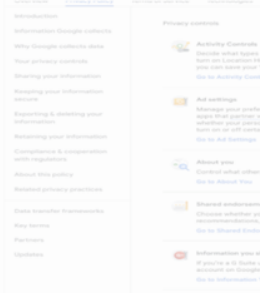
Sign in

New user? **Create an account**

Adobe

G — Continue with Google

f — Continue with Facebook

 — Continue with Apple

Don't sign into apps with social networking site account

wnload
l sources

'N for
i networks

How to protect your personal information?

Google Priva...

Read the priv...

Check app p...

Security

Passwords
Make passwords visible

Device administration
Device administrators
View or deactivate device administrators

Unknown sources
Allow installation of apps from sources other than the Play Store

Storage type
Hardware-backed

Trusted credentials
Display trusted CA certificates

Install from storage
Install certificates from storage

Lock screen and security

Lock screen
Screen lock type
None

Unknown sources

Installing from unknown sources may be harmful to your device and personal data. By tapping OK, you agree that you are solely responsible for any damage to your device or loss of data that may result from using these applications.

☐ Allow this installation only

CANCEL   OK

Scan Code

Scan codes from your friends. You can get a code to add new contacts or join groups.

Allow GroupMe to take pictures and record video?

☐ Don't ask me again

DENY   ALLOW

Security

Make passwords visible

Unknown sources

Your phone and personal data are more vulnerable to attack by apps from unknown sources. You agree that you are solely responsible for any damage to your phone or loss of data that may result from using these apps.

CANCEL   OK

Trusted credentials

Install from storage

...ownload
...ed sources

Internet Service Provider   VPN Server   Internet

Internet Service Provider   Internet

...PN for
...Fi networks

Only download from trusted sources

How to protect your personal information?
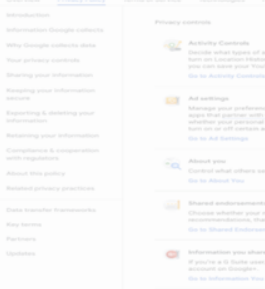

Read the priva...

Scan Code

Scan codes from your friends. You can get a code to add new contacts or join groups.

Allow GroupMe to take pictures and record video?

☐ Don't ask me again

DENY   ALLOW

Waiting for permission to access camera...

Your location

University of Michigan Sc...

Finding best route...

Allow Maps to access this device's location?

☐ Don't ask me again

DENY   ALLOW
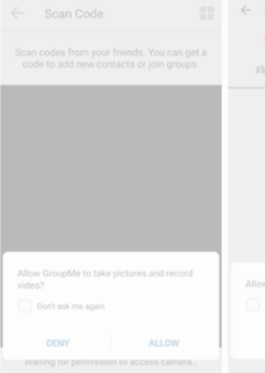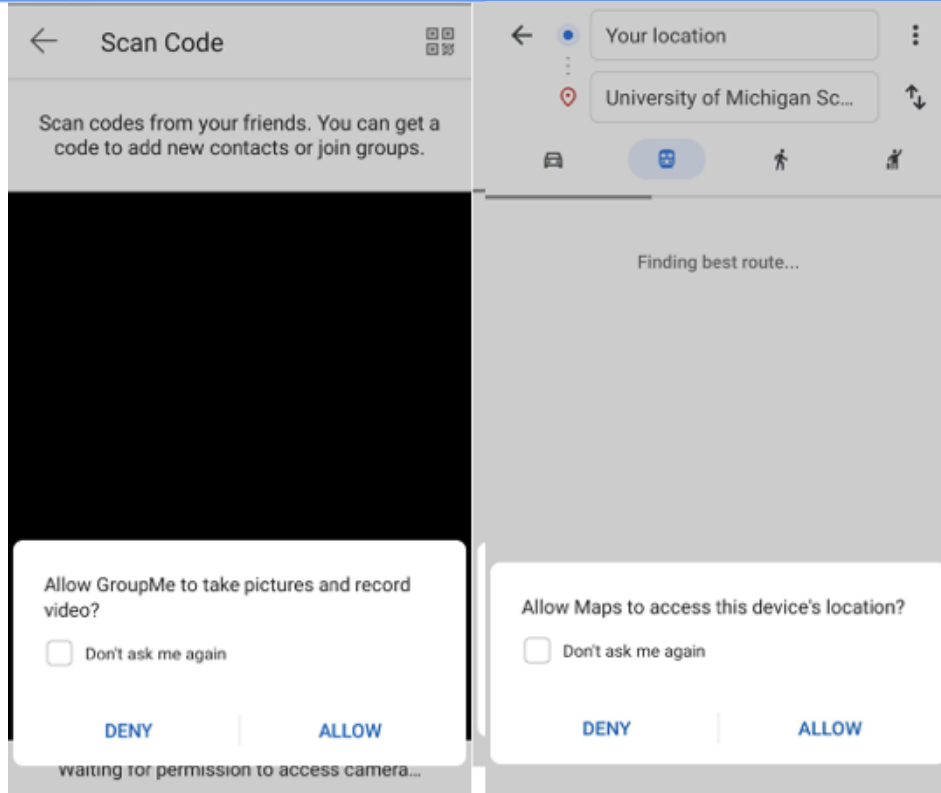
Check app permissions

download
usted sources

e VPN for
Wi-Fi networks

Check app pe...

How to protect your personal information?

Read the pri...

Check app ...

Keep apps update

...wnload
...ed sources

...VPN for
...Fi networks
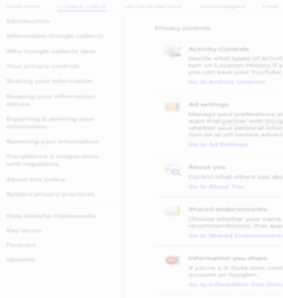
How to protect your personal information?

Use VPN for
public Wi-Fi networks

Read the privac...
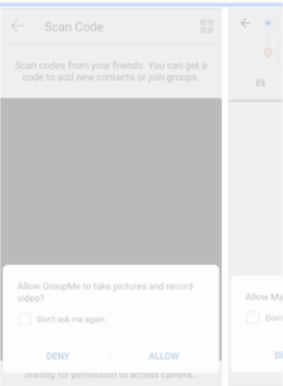
...y download
...rusted sources

Check app per...
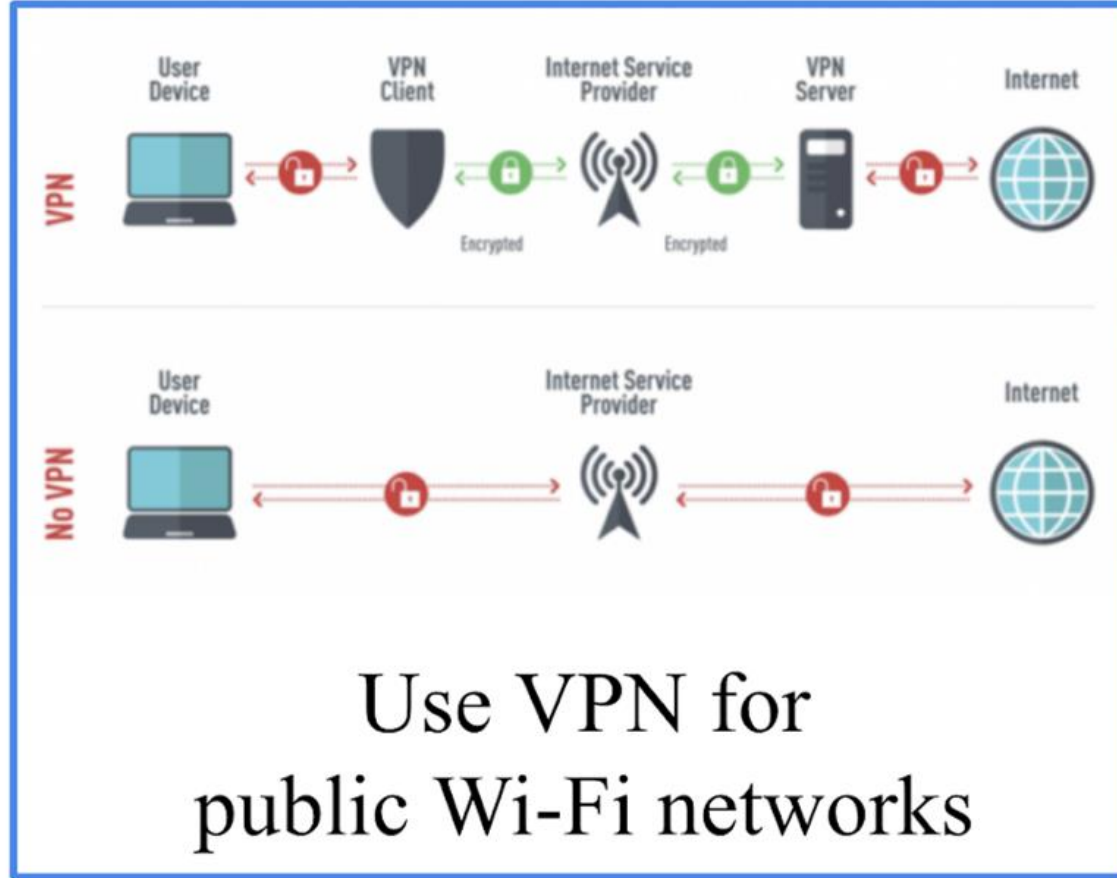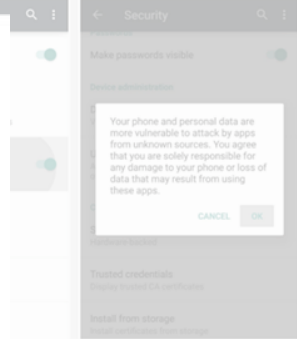
...se VPN for
...Wi-Fi networks

Experiment Methodology and Design

DESCRIBE   SPECIFY   DESIGN   COLLECT   FIT   PREDICT

We Did Large Scale Field Experiments (2015-2019)
Randomized Controlled Trial (RCT)

Experiment Specifics

- **300,000 survey applicants**
- **3 continents(North America, Europe, Asia)**
- **Survey Q&A on 22 mobile app types**
- **'Incentive' and 'Non-Incentive' Options**
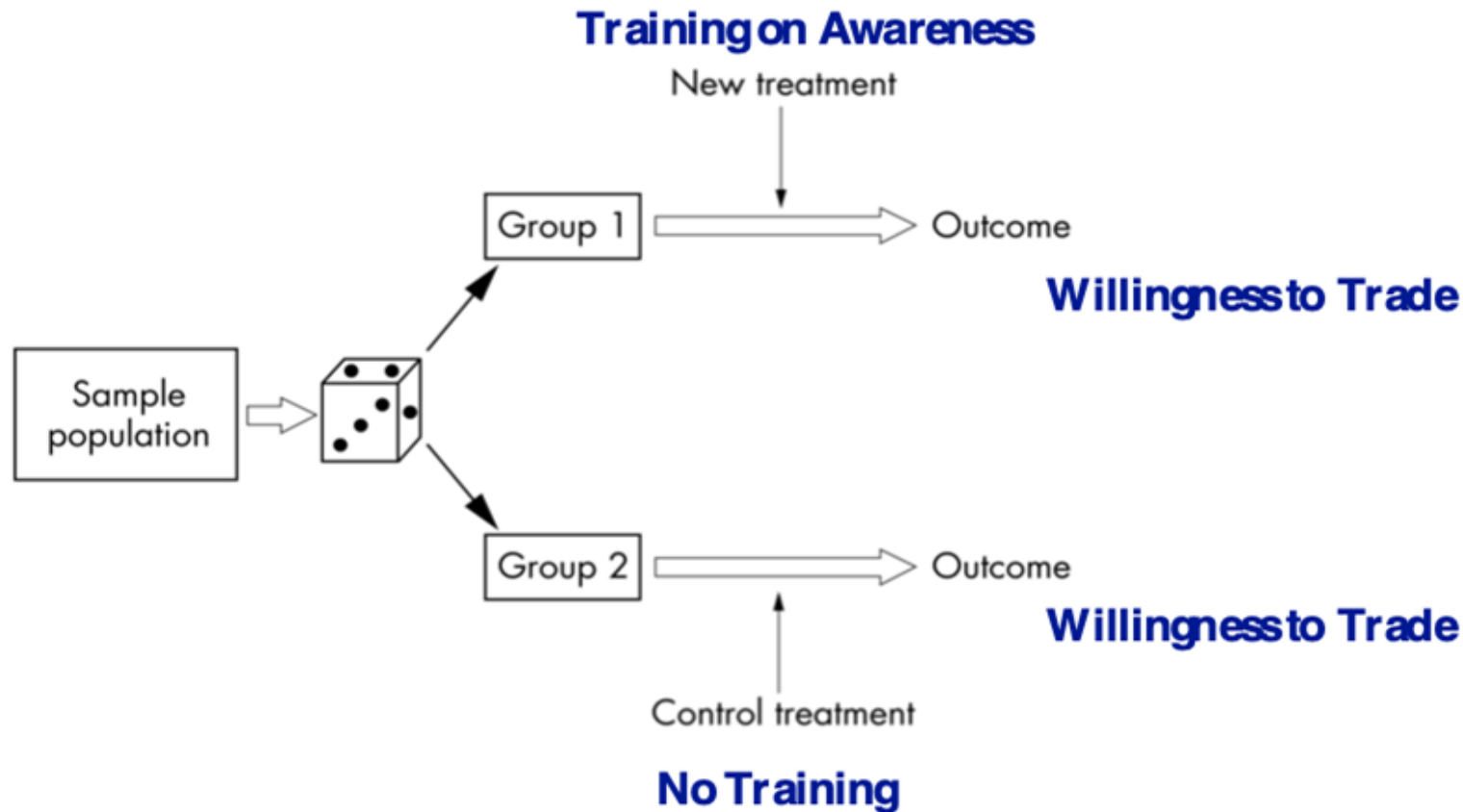
Gender: (Male/Female/Other)

Profession: (Celebrity/Homemaker/University/Corporation/Local)

Zone: (Europe/North America/India/China)

Do You Usually Use Social Network Accounts to Access Apps? (Yes/No)

Rate the following on a scale of 0 (not willing) to 10 (highly willing):

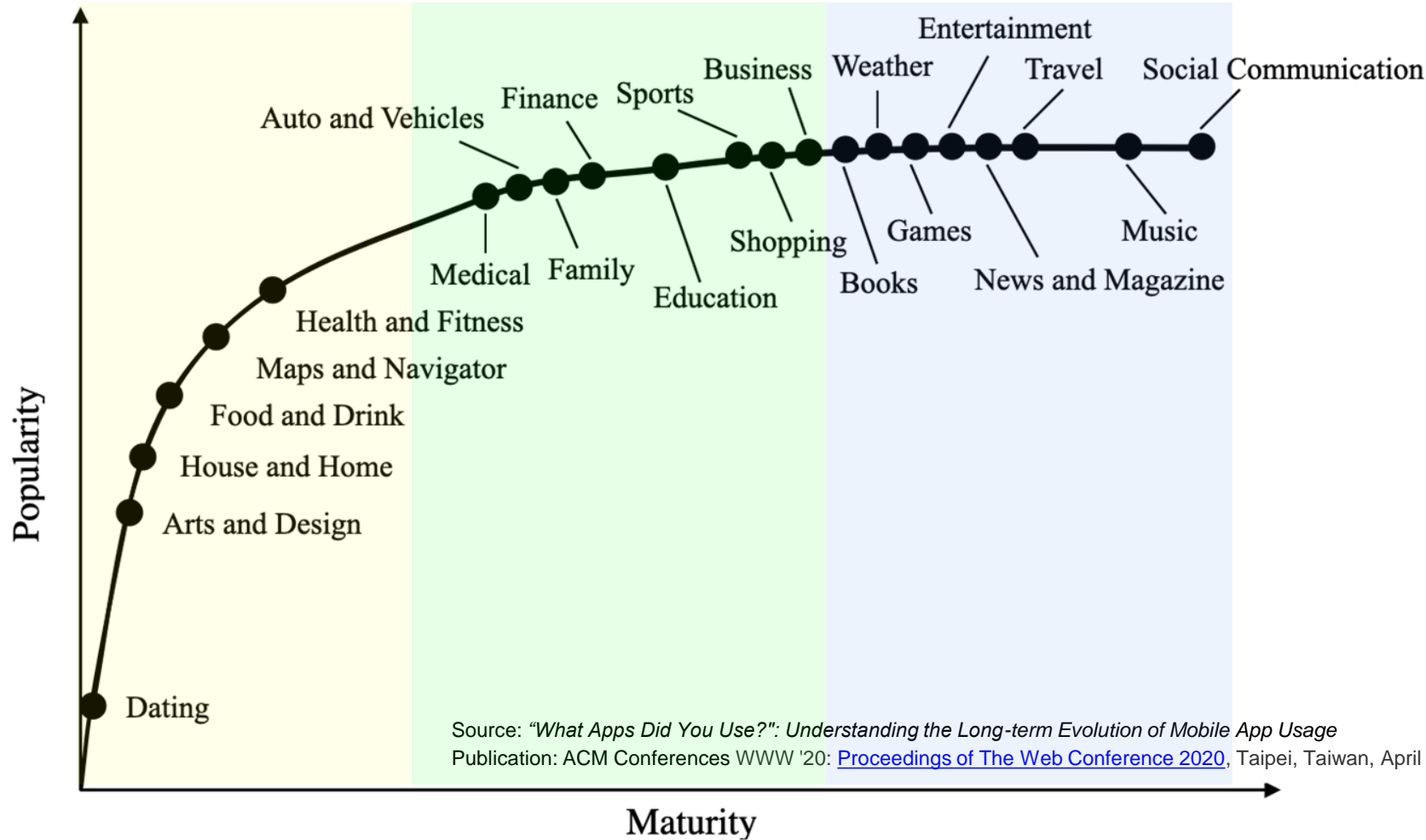| App Category	Interest to trade without any incentive	Interest to trade if given few cents as incentive	Interest to trade if given $1 as incentive	Interest to trade if given more than $1 as incentive
Dating				
Arts and Design	No incentive	Few cents as incentives	$1 as incentives	>$1 as incentives
House and Home				
Food and Drink				
Maps and Navigator				
Health and Fitness				
Auto/Vehicles				
Medical				
Family				
Finance				
Education				
Shopping				
Sports				
Business				
Books				
Weather				
Games				
Entertainment				
News/Magazine				
Travel				
Music				
Social Communication				

3.5 cents / unit data,
Uncertainty, Ambiguity and Privacy,
Submitted to WEIS 2005

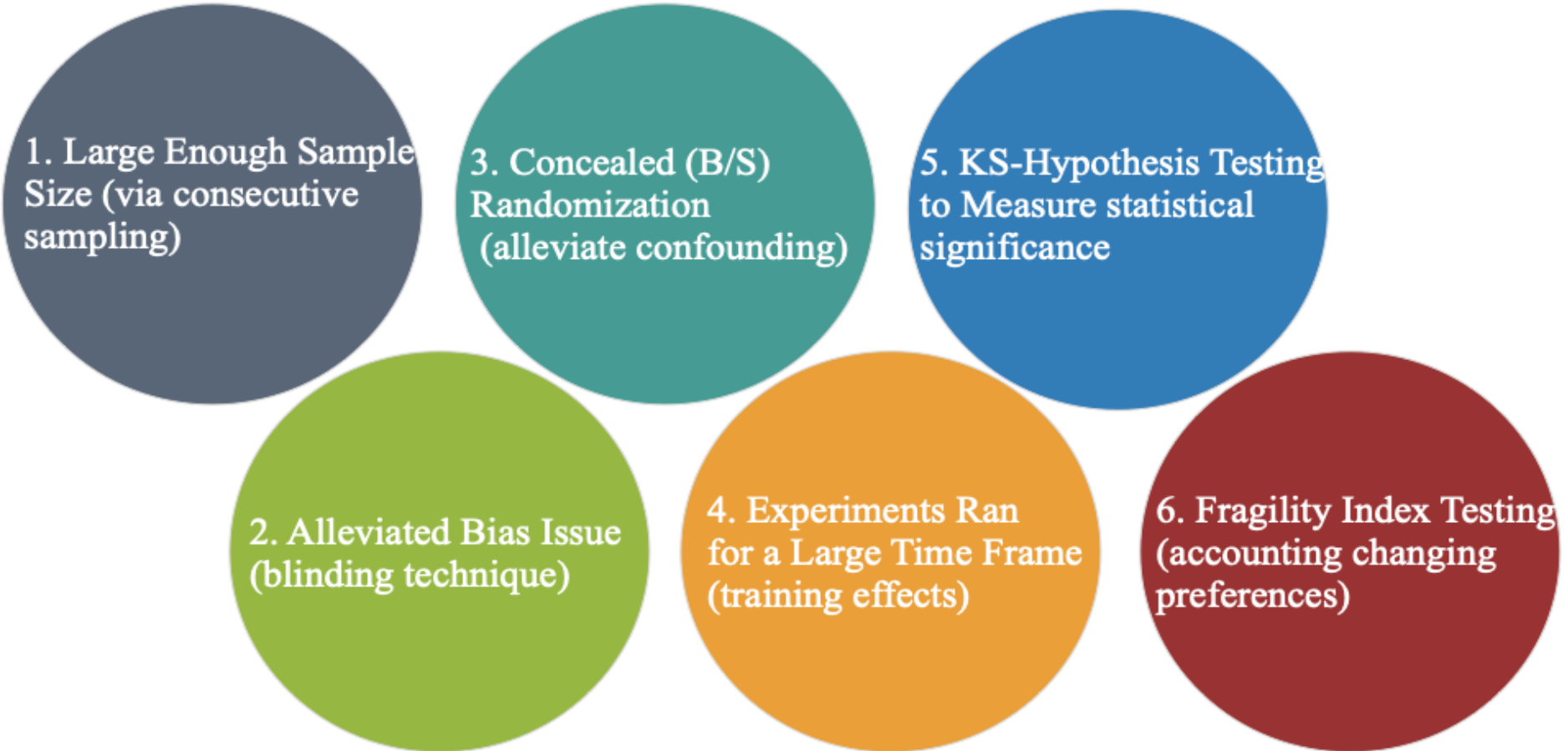Saturation Level for Different Categories of Apps

Source: *"What Apps Did You Use?": Understanding the Long-term Evolution of Mobile App Usage*
Publication: ACM Conferences WWW '20: Proceedings of The Web Conference 2020, Taipei, Taiwan, April 2020

Six Steps to Conduct RCT "Correctly"

1. Large Enough Sample Size (via consecutive sampling)

2. Alleviated Bias Issue (blinding technique)

3. Concealed (B/S) Randomization (alleviate confounding)

4. Experiments Ran for a Large Time Frame (training effects)

5. KS-Hypothesis Testing to Measure statistical significance

6. Fragility Index Testing (accounting changing preferences)

Recommended by the paper: Improving the quality of reporting of randomised controlled trials: the CONSORT statement.
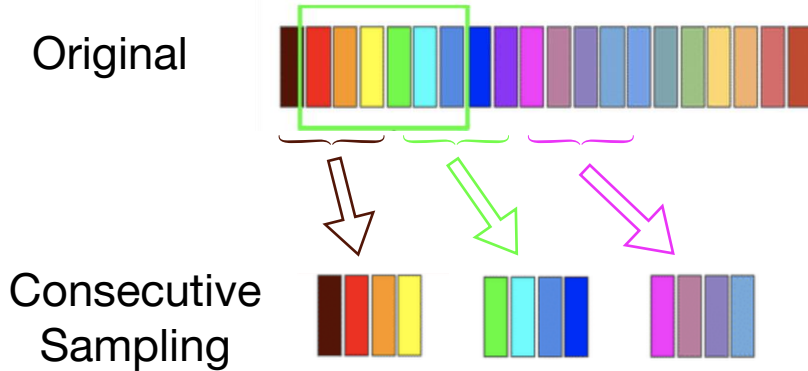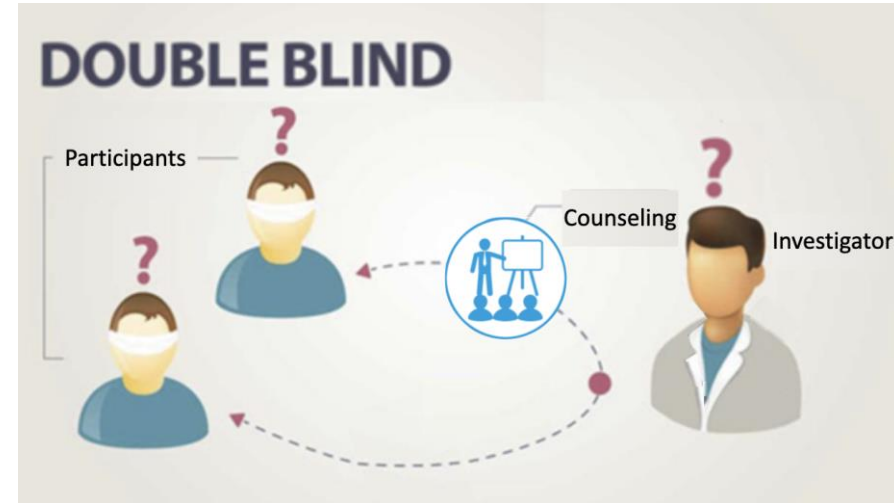
1. Large Enough Sample Size (via consecutive sampling)

To mitigates chance error, when sampling

- Consecutive sampling for normal people
- Stratified sampling for celebrities

Original

Consecutive Sampling

2. Alleviated Bias Issue (blinding technique)

- Selection Bias
- Observation Bias

DOUBLE BLIND

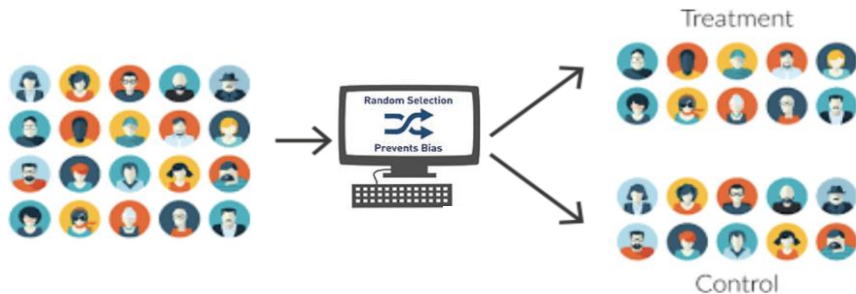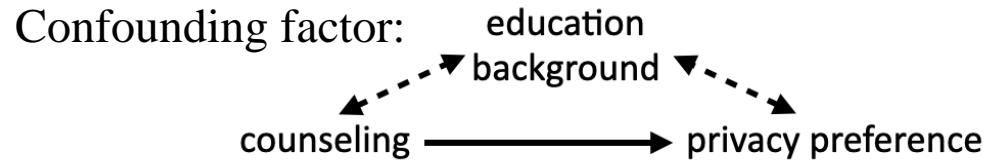Participants

Counseling

Investigator

3. Concealed (B/S) Randomization (alleviate confounding)

if (confounding factor is known)
    {Stratified randomization}
else (confounding factor not known)
    {Blocked Randomization}

Confounding factor:

4. Experiments Ran for a Large Time Frame (training effects)

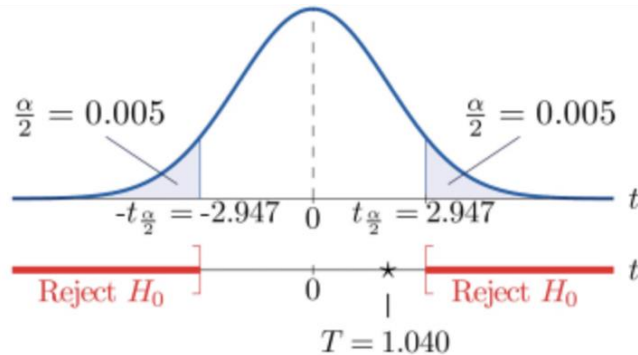If (some participants changed views towards a bad privacy preference)
    {we include them}

5. KS-Hypothesis Testing to Measure statistical significance
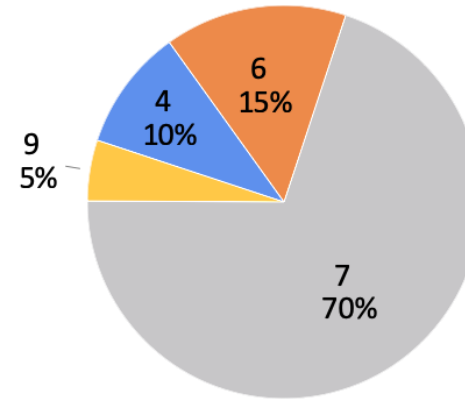
We rejected hypothesis that

Given incentives, the training could have

a major influence on trading preferences.

(change trading preferences > 10%)

$$\frac{\alpha}{2} = 0.005 \qquad \frac{\alpha}{2} = 0.005$$

$$-t_{\frac{\alpha}{2}} = -2.947 \quad 0 \quad t_{\frac{\alpha}{2}} = 2.947$$

Reject H_0 0   Reject H_0

$$T = 1.040$$

6. Fragility Index Testing (accounting changing preferences)

Fragility Index Testing

Indicates:

low degree of fragility

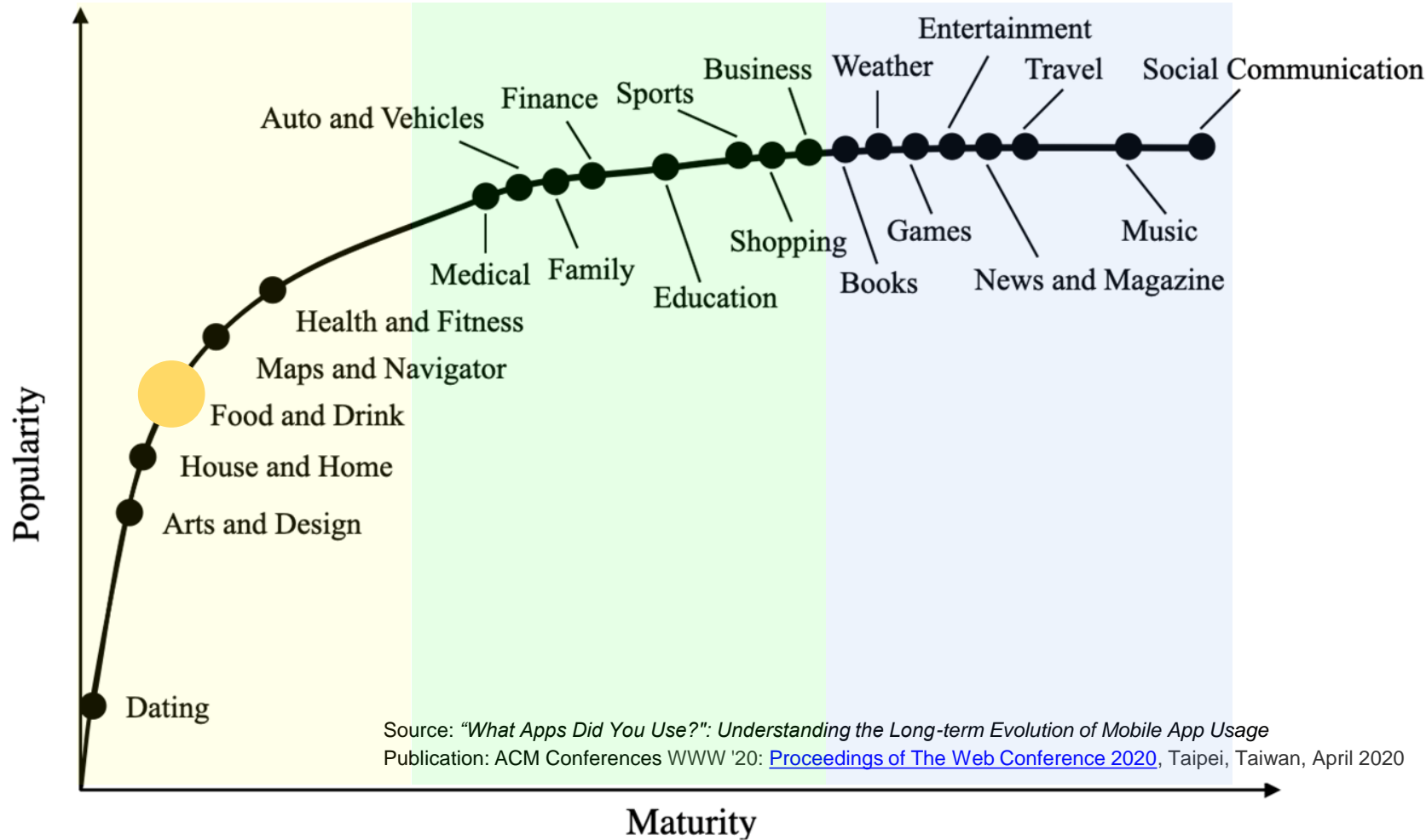| Trial Result		
	Event	No Event
Treatment A	a	b
Treatment B	c	d
Fisher's Exact Test p<0.05		

Calculated Fragility		
	Event	No Event
Treatmnt A	a+f	b-f
Treatment B	c	d
Fisher's Exact Test p≥0.05		

Results and Analysis

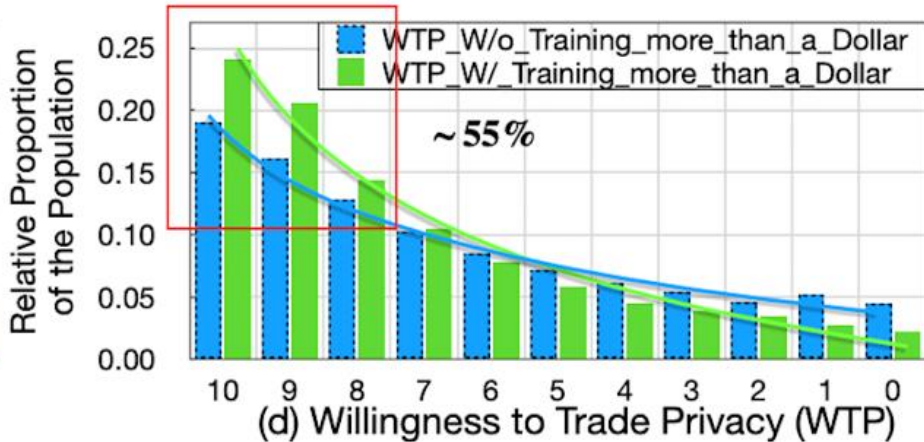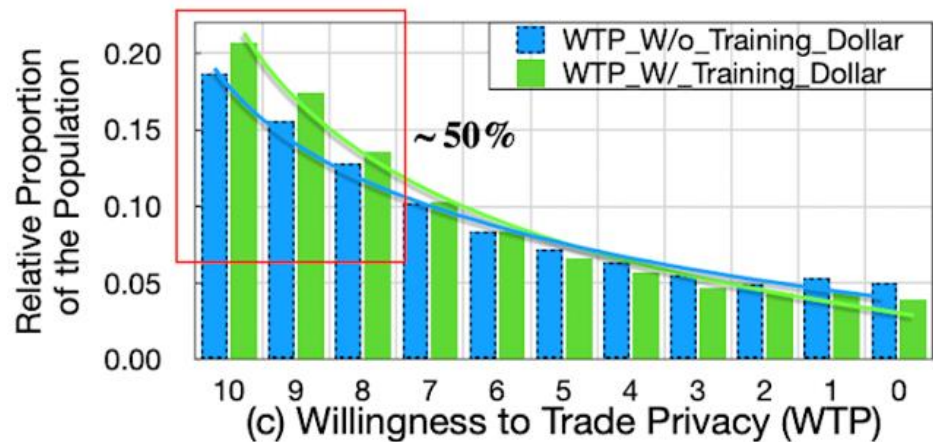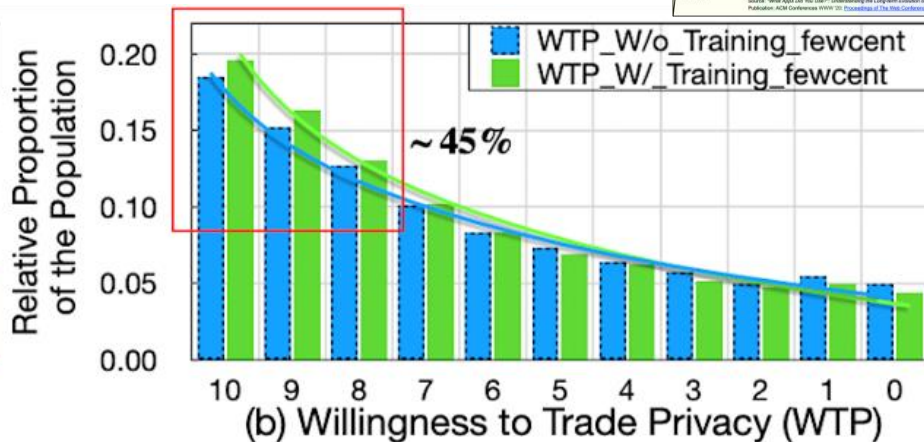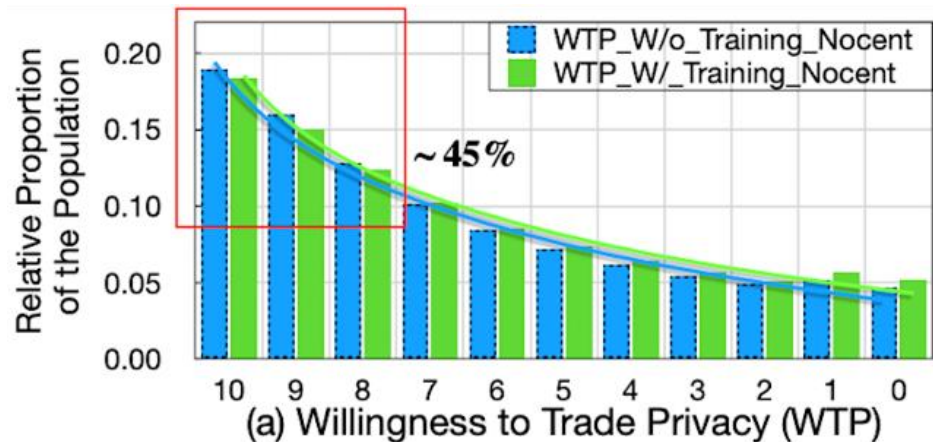Saturation Level for Different Categories of Apps

Popularity (y-axis) vs Maturity (x-axis)

Categories (from low to high maturity): Dating, Arts and Design, House and Home, Food and Drink, Maps and Navigator, Health and Fitness, Auto and Vehicles, Medical, Finance, Family, Sports, Education, Business, Shopping, Weather, Books, Games, Entertainment, News and Magazine, Travel, Music, Social Communication

Source: *"What Apps Did You Use?": Understanding the Long-term Evolution of Mobile App Usage*
Publication: ACM Conferences WWW '20: Proceedings of The Web Conference 2020, Taipei, Taiwan, April 2020

Entertainment
Business Weather Travel Social Communication
Finance Sports
Auto and Vehicles
Medical Family Games
Shopping
Education Books News and Magazine Music
Health and Fitness
Maps and Navigator
Food and Drink
House and Home
Arts and Design

Dating

Popularity

Maturity

Source: *"What Apps Did You Use?": Understanding the Long-term Evolution of Mobile App Usage*
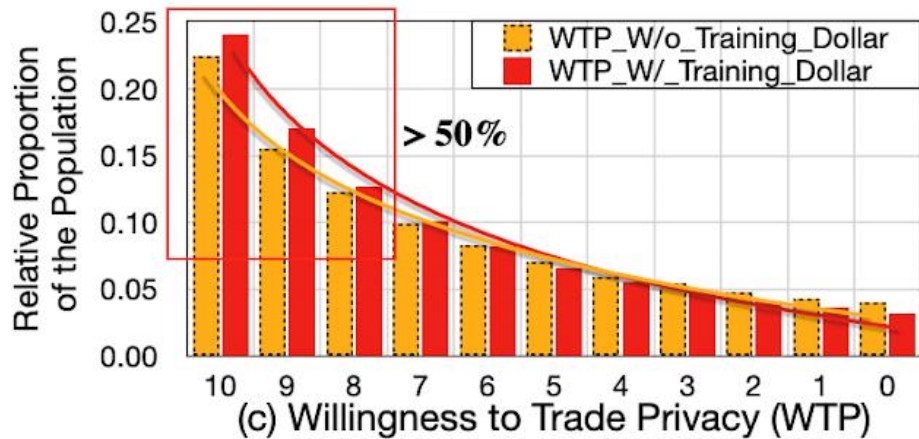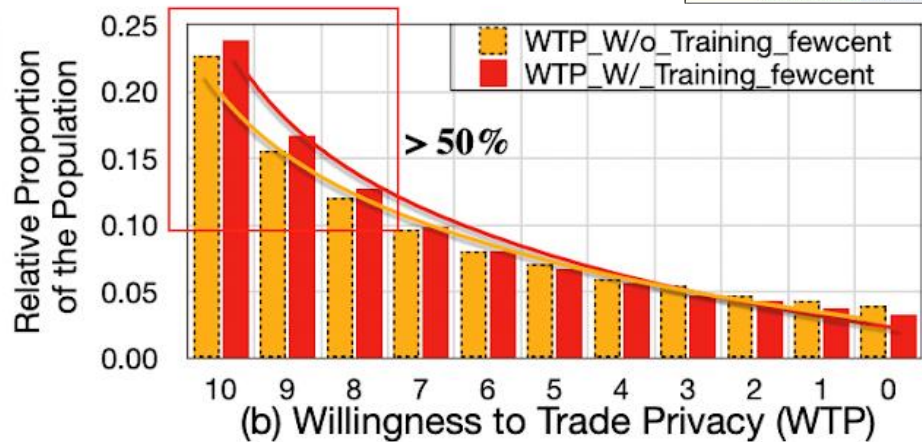Publication: ACM Conferences WWW '20: Proceedings of The Web Conference 2020, Taipei, Taiwan, April 2020

Saturation Level for Different Categories of Apps

WTP for Food and Drink Apps

(a) Willingness to Trade Privacy (WTP)

(b) Willingness to Trade Privacy (WTP)

(c) Willingness to Trade Privacy (WTP)

(d) Willingness to Trade Privacy (WTP)

WTP for Food and Drink Apps

(a) Willingness to Trade Privacy (WTP)

(b) Willingness to Trade Privacy (WTP)

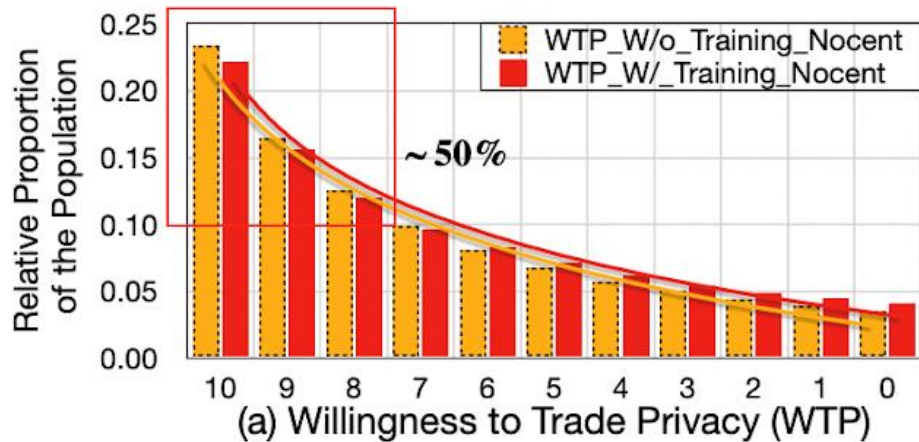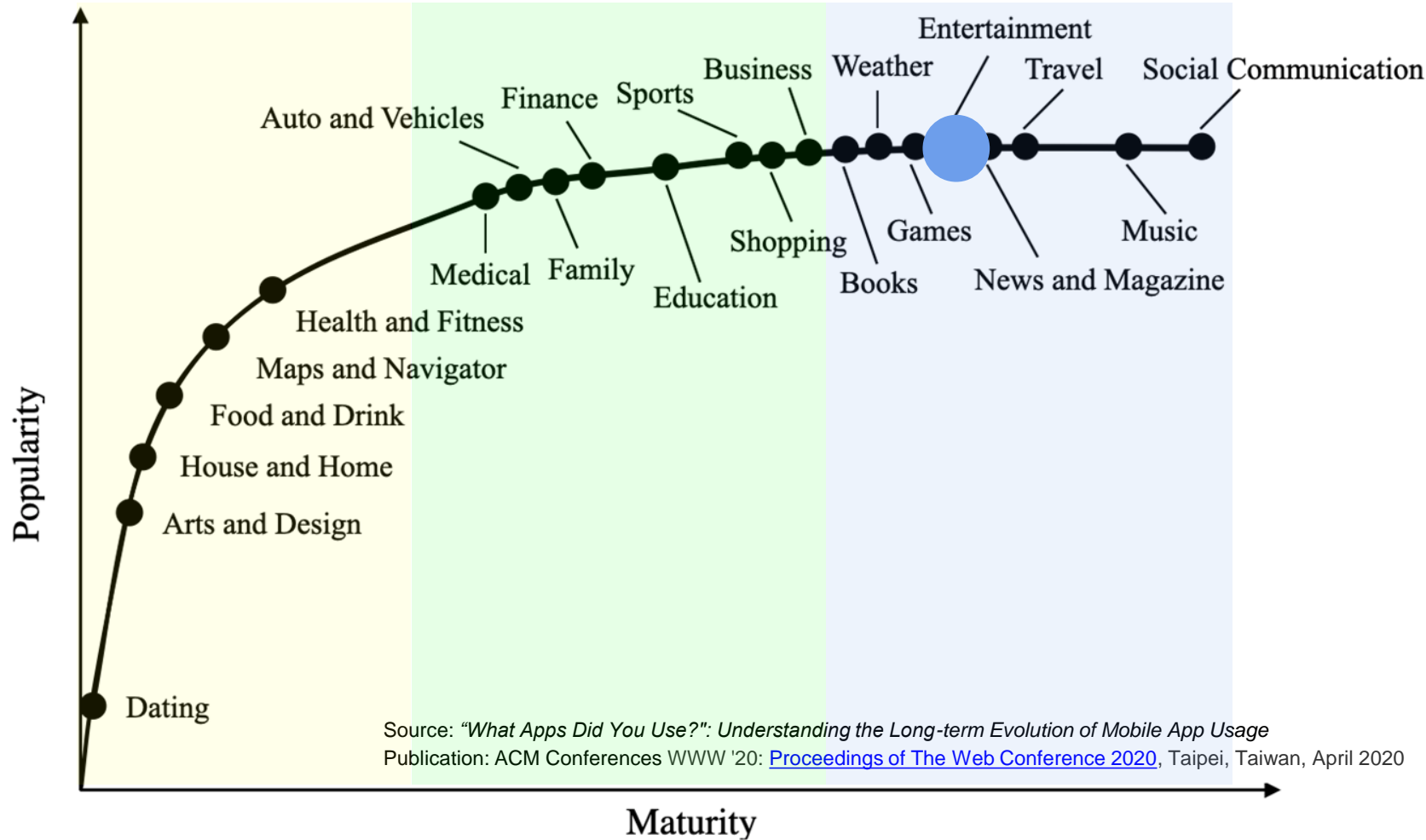Saturation Level for Different Categories of Apps

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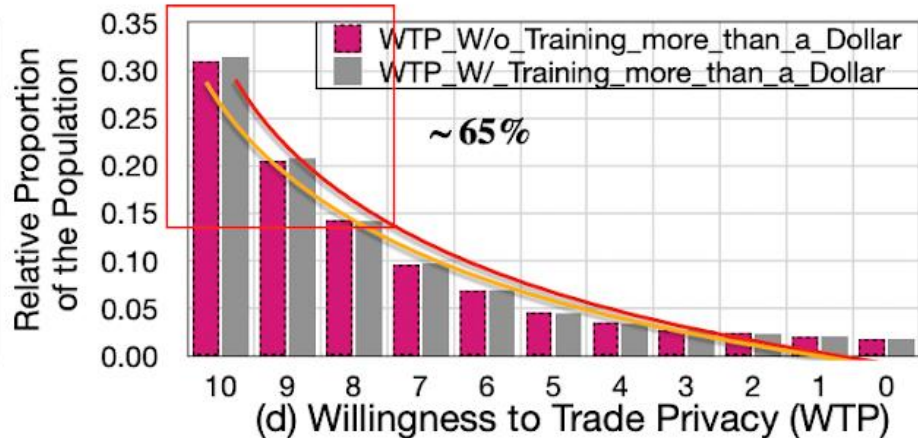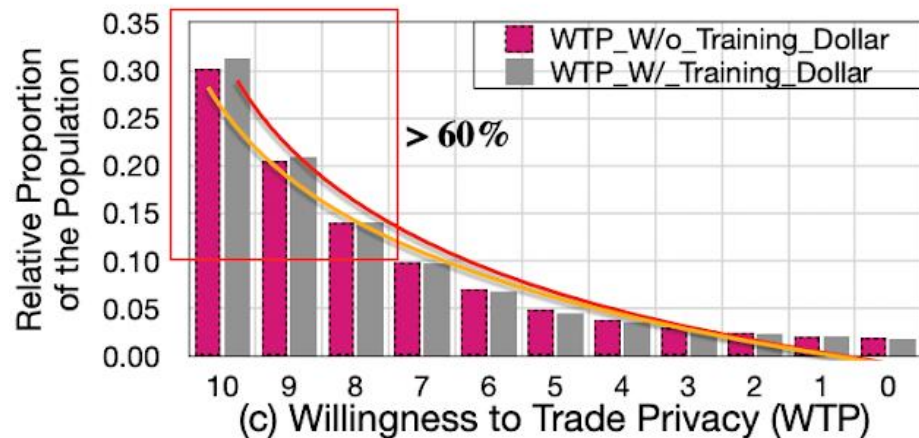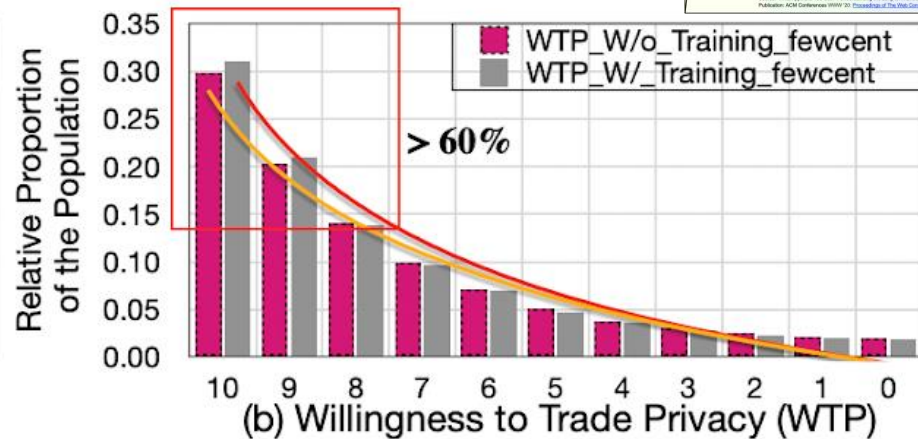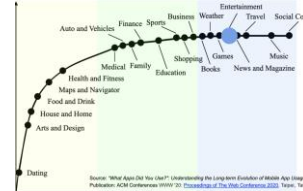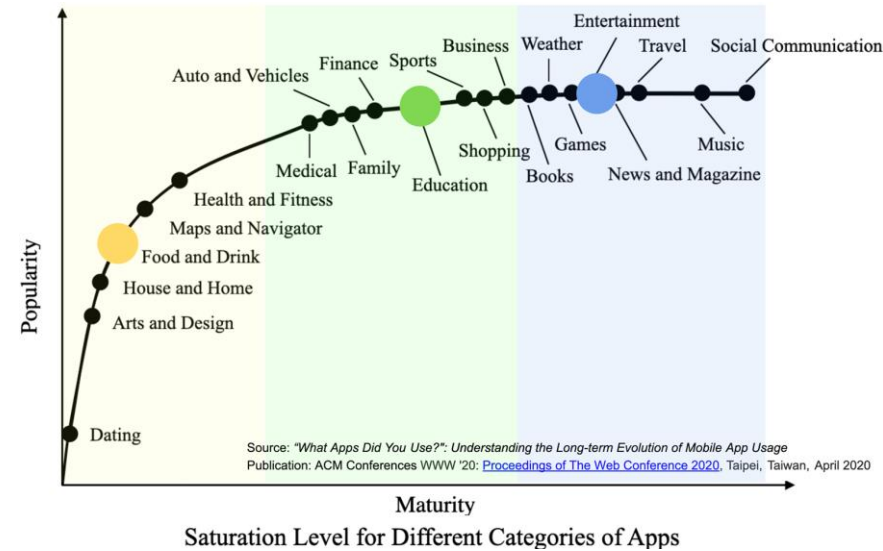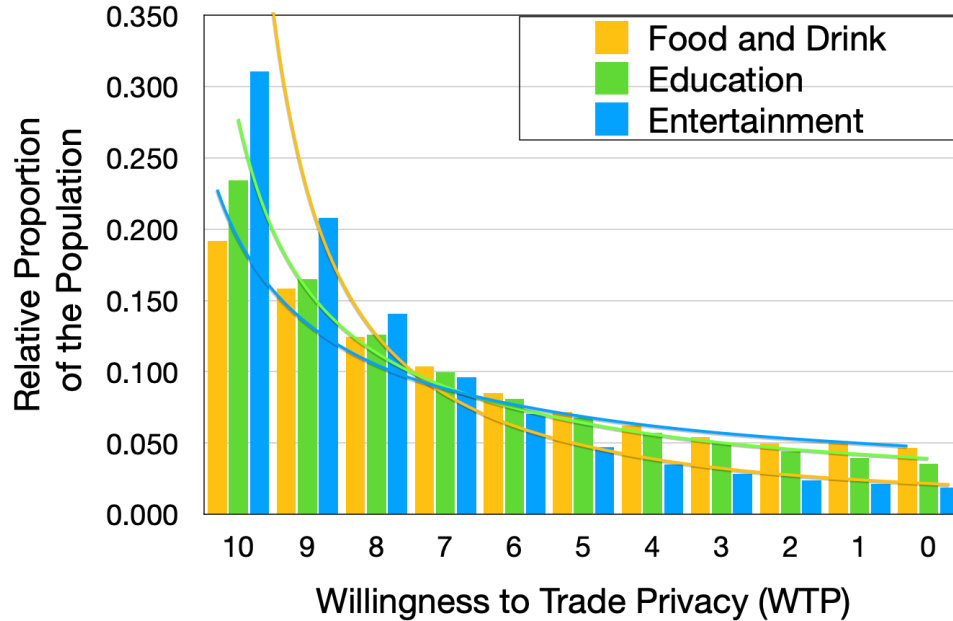
WTP for Education Apps

(a) Willingness to Trade Privacy (WTP)

(b) Willingness to Trade Privacy (WTP)

(c) Willingness to Trade Privacy (WTP)

(d) Willingness to Trade Privacy (WTP)

Saturation Level for Different Categories of Apps

Popularity (y-axis), Maturity (x-axis)

Dating, Arts and Design, House and Home, Food and Drink, Maps and Navigator, Health and Fitness, Auto and Vehicles, Medical, Family, Finance, Education, Sports, Shopping, Business, Books, Weather, Games, Entertainment, News and Magazine, Travel, Music, Social Communication

WTP for Entertainment Apps

(a) Willingness to Trade Privacy (WTP)

(b) Willingness to Trade Privacy (WTP)

(c) Willingness to Trade Privacy (WTP)

(d) Willingness to Trade Privacy (WTP)

WTP for 3 Apps

With incentive, nearly half of the users are willing to trade privacy.

WTP for 3 Apps

Source: "What Apps Did You Use?": Understanding the Long-term Evolution of Mobile App Usage
Publication: ACM Conferences WWW '20: Proceedings of The Web Conference 2020, Taipei, Taiwan, April 2020

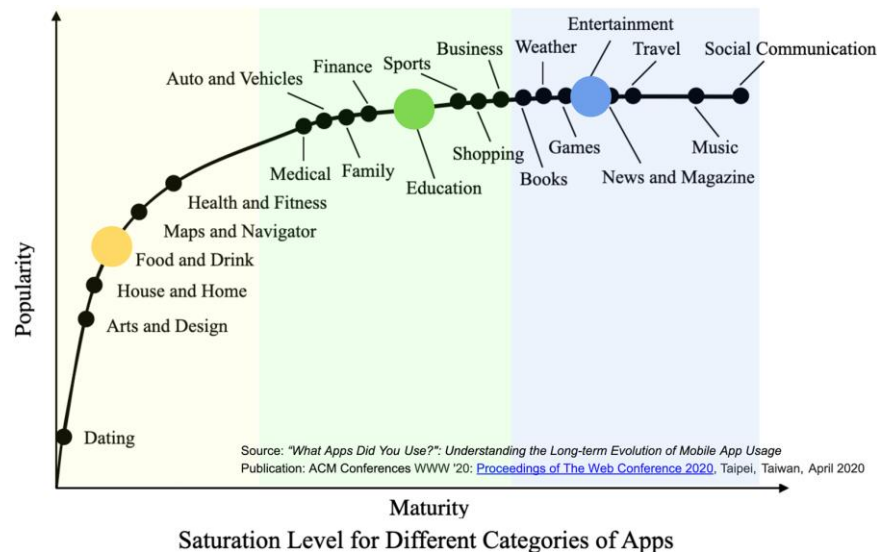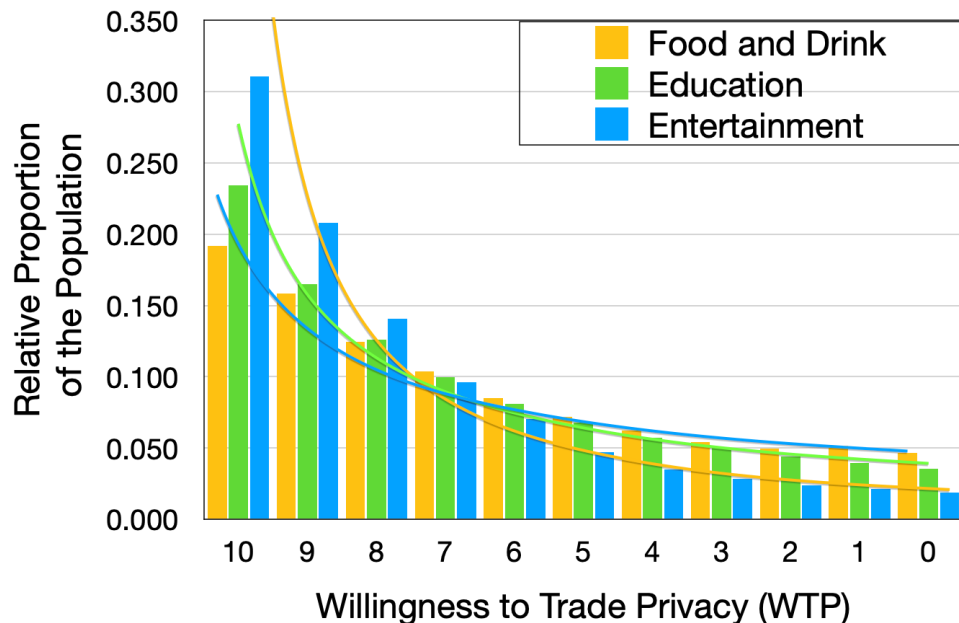**With incentive, nearly half of the users are willing to trade privacy.**

Preference Structures are Heavy-Tailed and *Weakly* Scale Free at Best.

How to Decide the Tail Structure?

Step 1. Find Best Filling in Distribution UpperTail

⬇

Step 2. Evaluate Statistical Plausiblility using Goodness-of-Fit Test

⬇

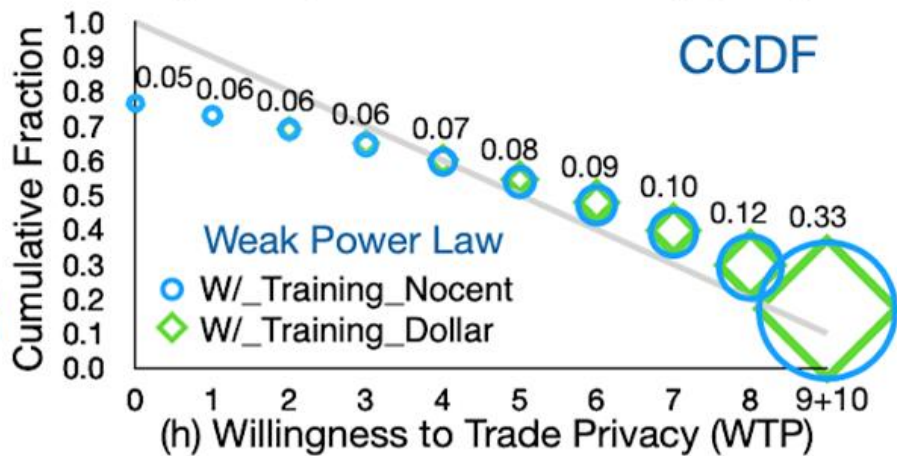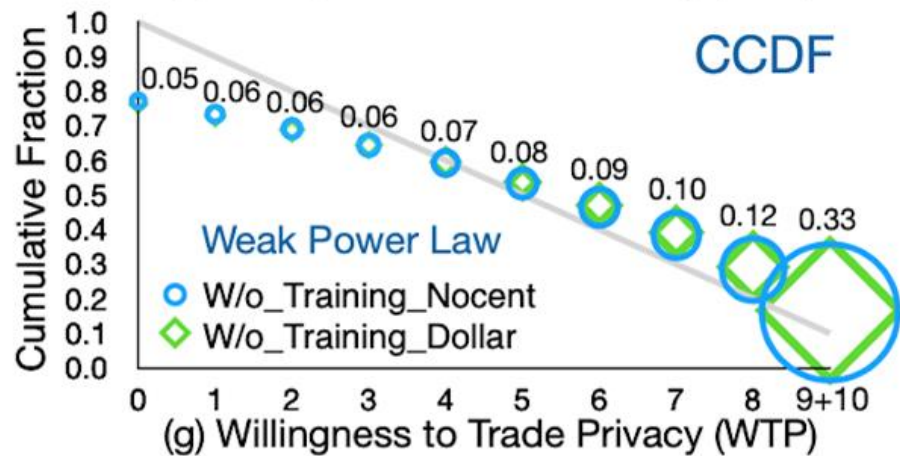**Step 3. Compare Plausibility to Alternative Distributions filled To same part of Upper Tail using Likelihood-Ratio Test**
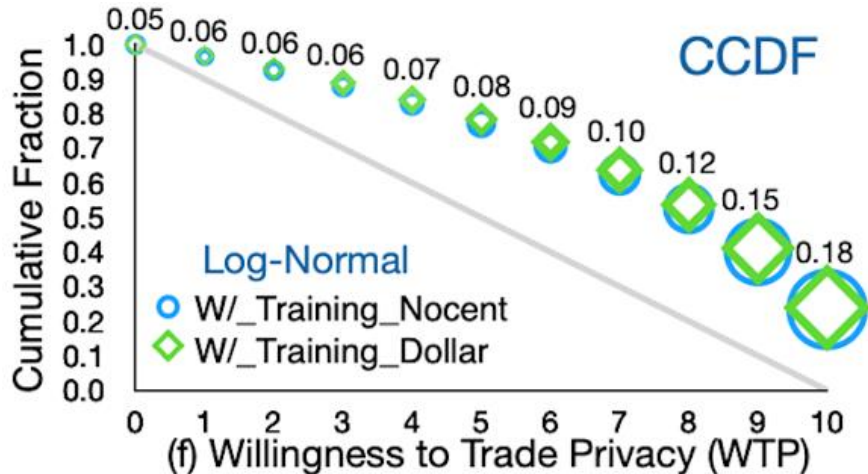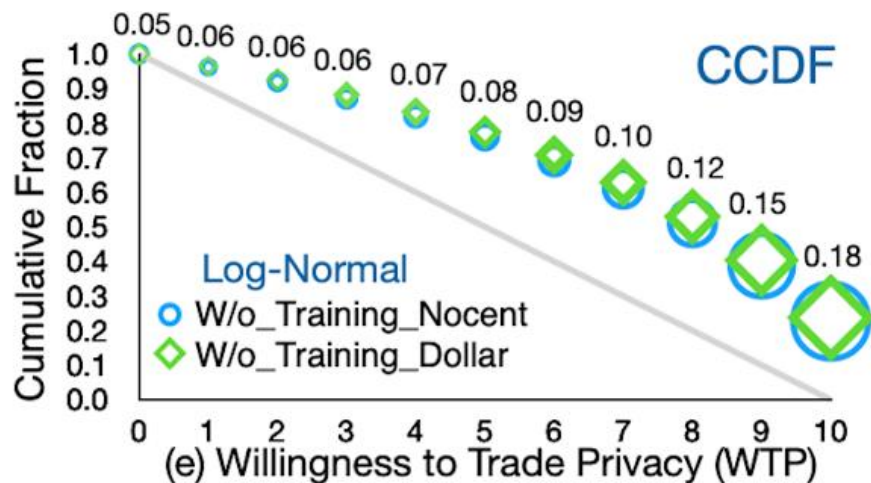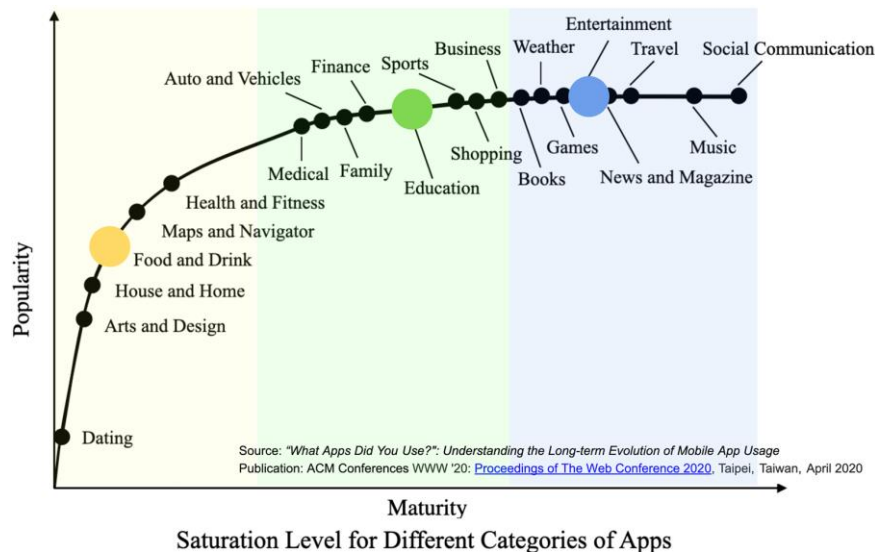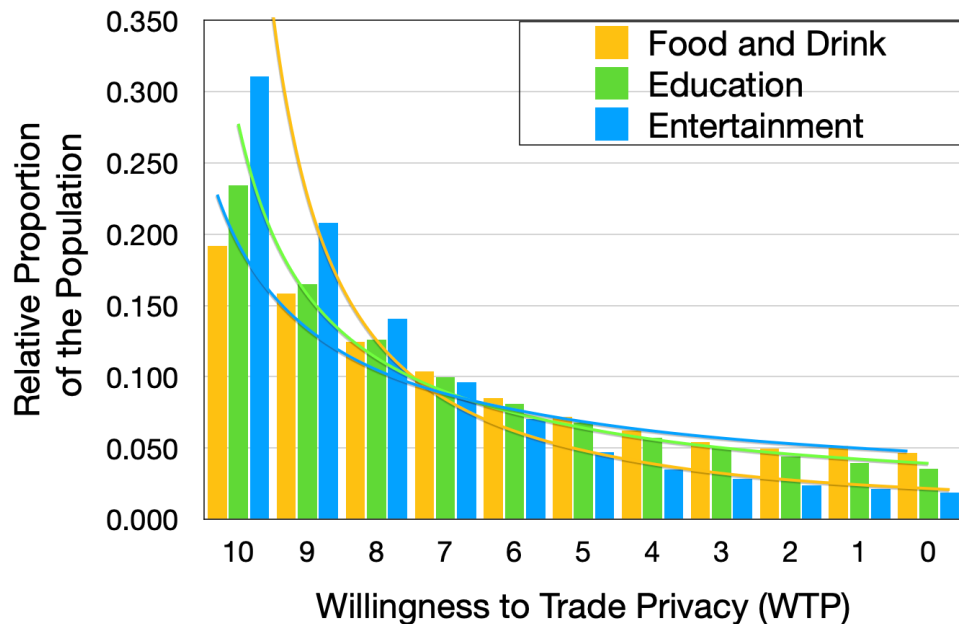
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-> Vuong Normalized Likelihood Ratio Test

-> 3 distribution: Scale Free, Log-Normal, Exponential

Step 4. Choose max Plausible structure

CCDF-Plot for **Food and Drink Apps**

WTP for 3 Apps

With incentive, nearly half of the users are willing to trade privacy.

Preference Structures are Heavy-Tailed and *Weakly* Scale Free at Best.

Thank you!

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