Conservation of Procrastination: Do Productivity Interventions Save Time or Just Redistribute It?

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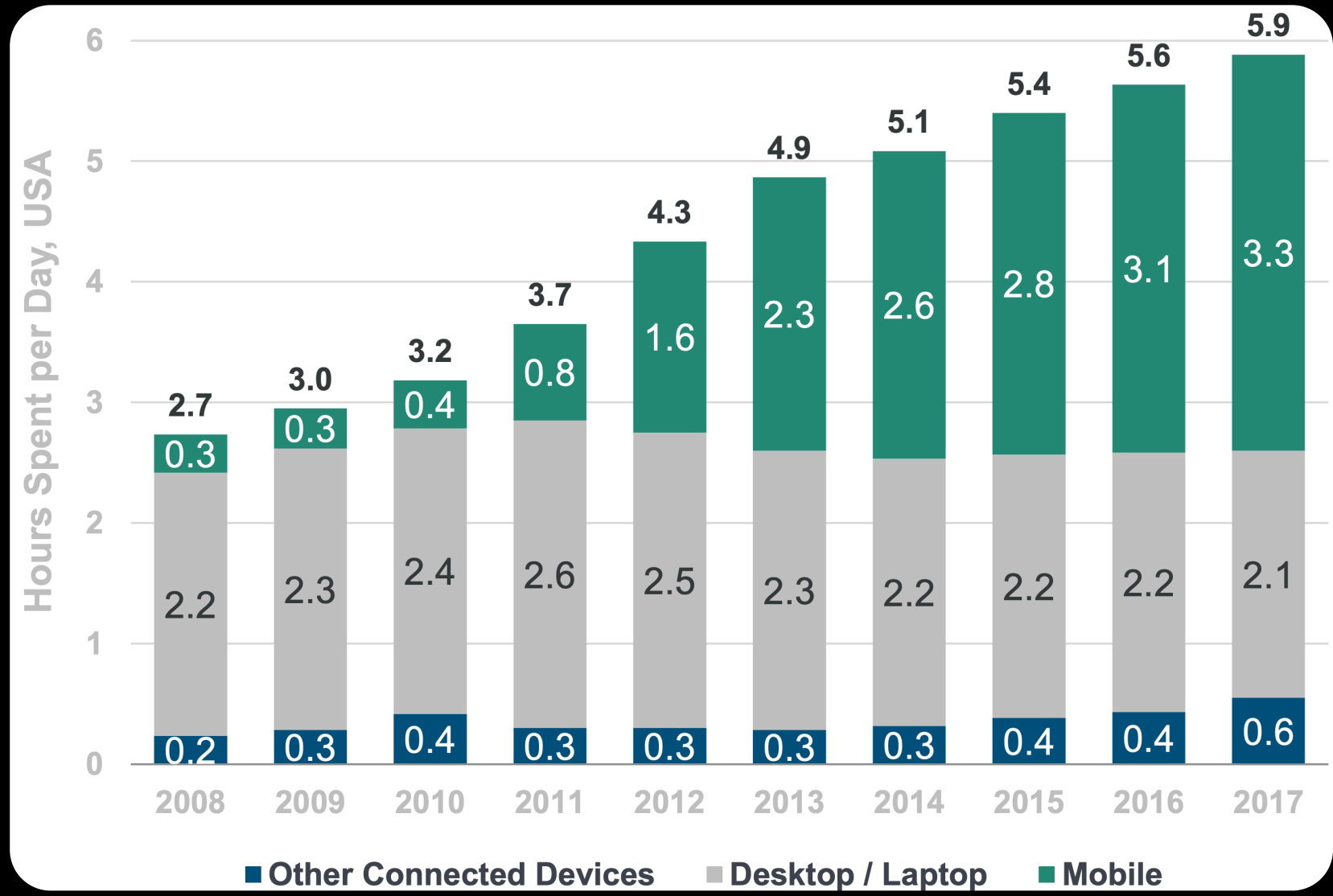
Stanford HCI Group

People spend increasing amounts of time online

Average US adult spends **5.9 hours** per day with digital media



Source: Kleiner Perkins 2018 Internet Trends

People struggle to reduce their time online

Kim, Young-Ho, et al. "TimeAware: Leveraging framing effects to enhance personal productivity." *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. ACM, 2016.

Andreassen, Cecilie Schou, et al. "Development of a Facebook addiction scale." *Psychological reports* 110.2 (2012): 501-517.

Users use productivity tools to help them reduce time online

Is that time actually saved, or just redirected to other unproductive activities?

We often assume that intervention effects are isolated

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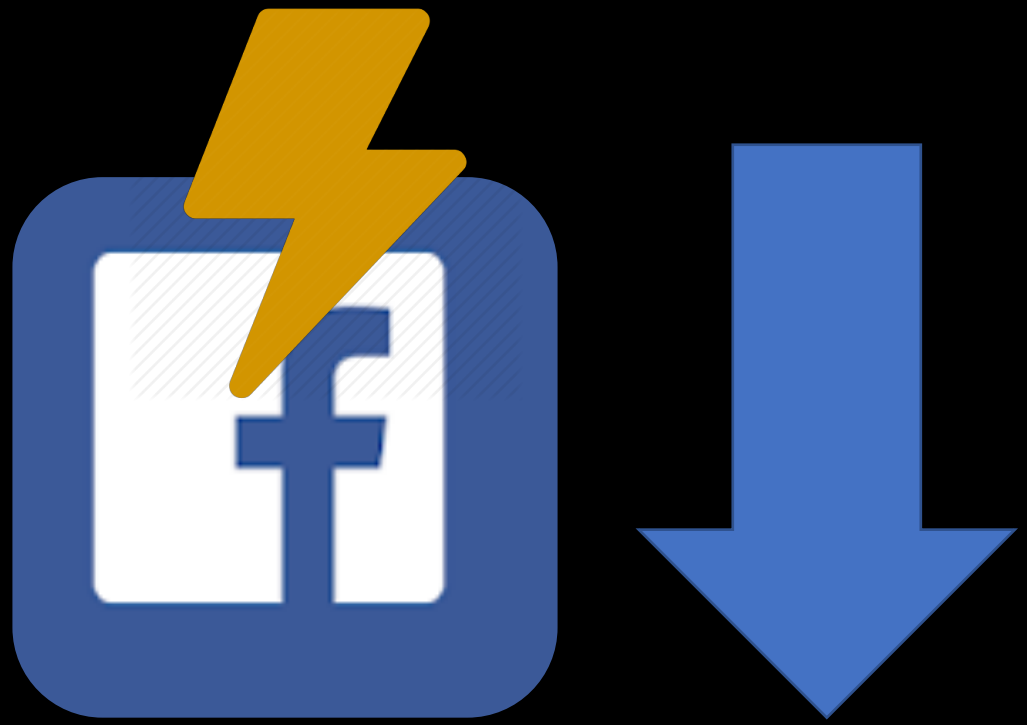

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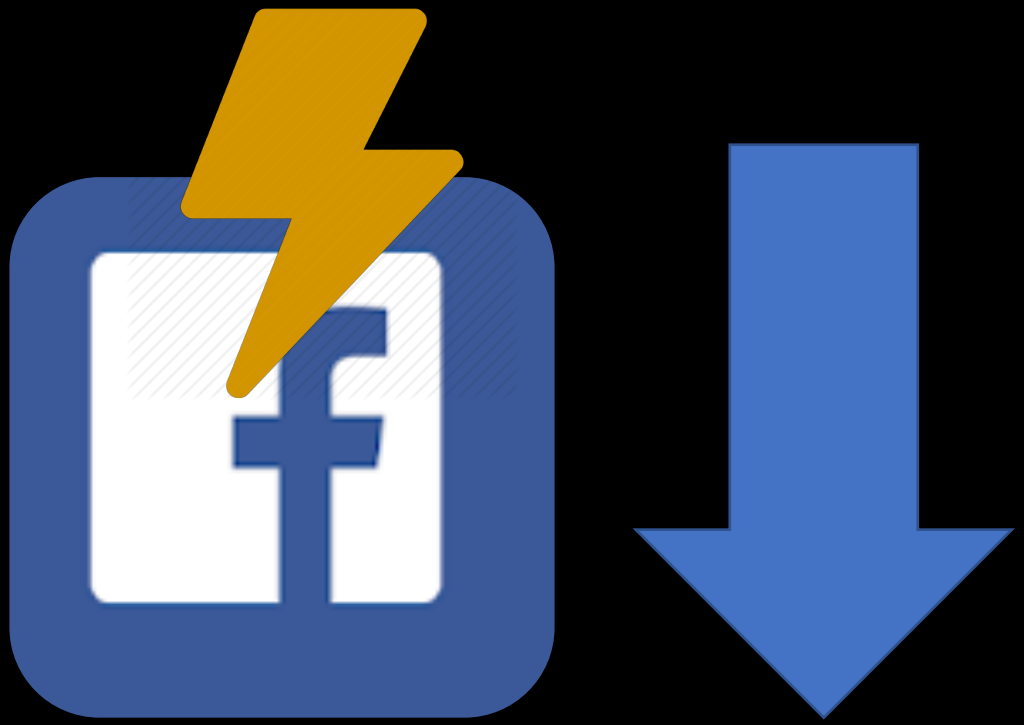

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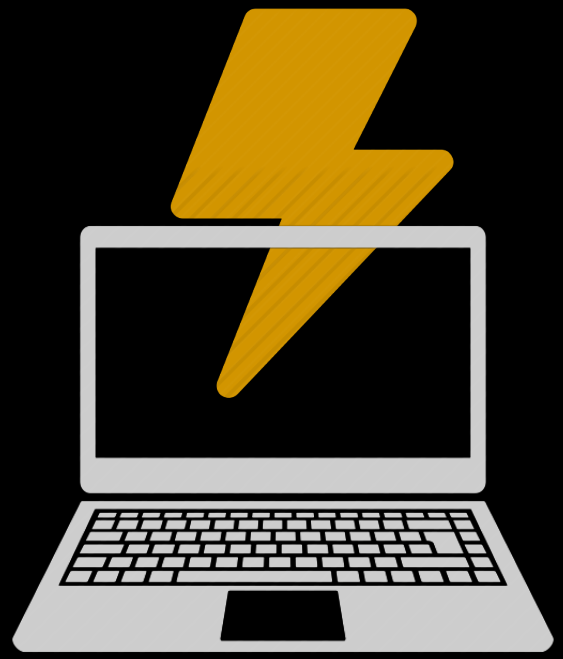
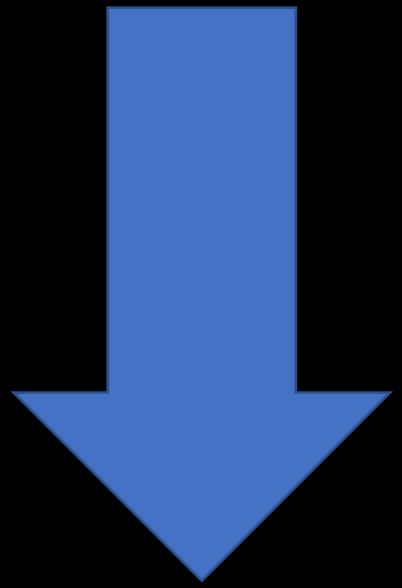
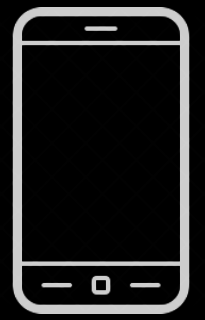
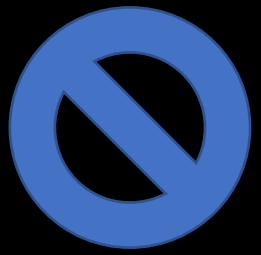








What if the time you saved is just shifted elsewhere?

We have a limited supply of willpower

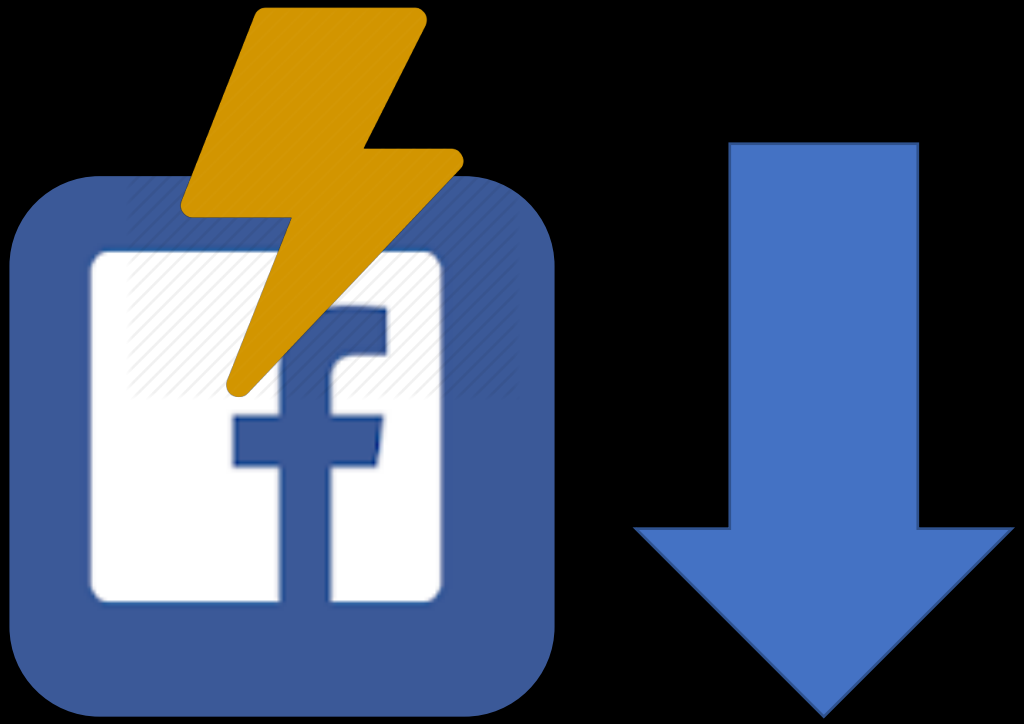
We need breaks and downtime

Laura Dabbish, Gloria Mark, and Víctor M González. 2011. Why do I keep interrupting myself?: Environment, Habit and Self-interruption. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, 3127–3130.

Roy E Baumeister, Ellen Bratslavsky, Mark Muraven, and Dianne M Tice. 1998. Ego Depletion: Is the Active Self a Limited Resource? Journal of Personality and Social Psychology 74, 5 (1998), 1252–1265.

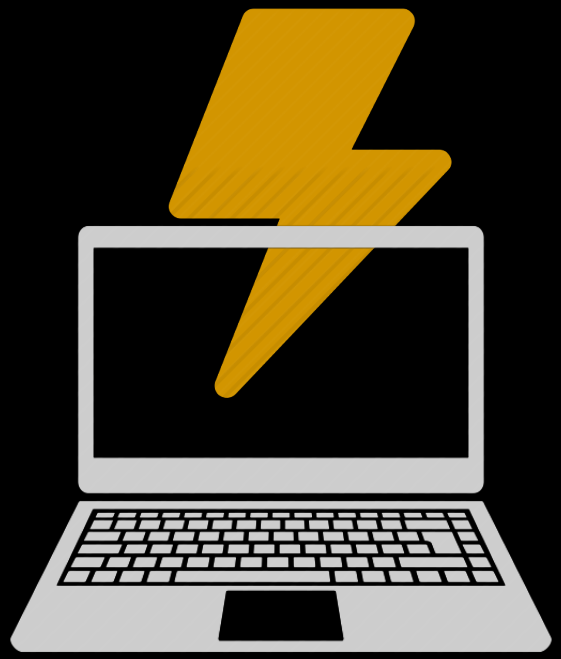
Is there a conservation-of-procrastination effect?

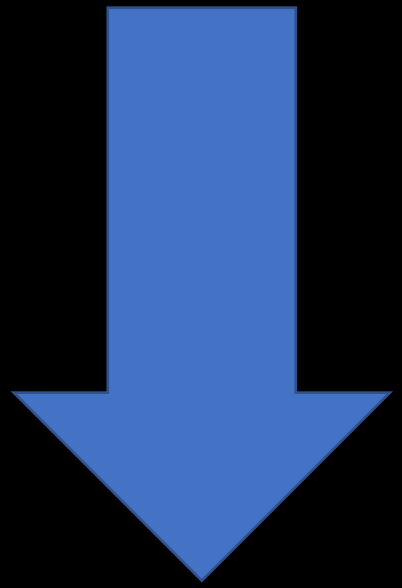
Does reducing time on one site or app **increase** time on others?

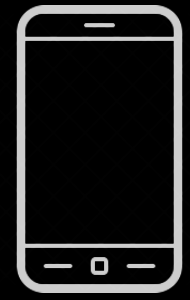


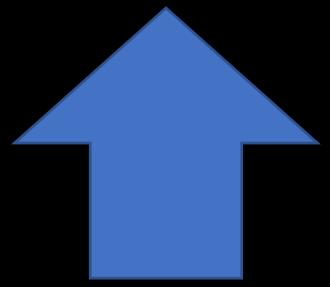
Is there a conservation-of-procrastination effect?

Does reducing time on one device **increase** time on others?





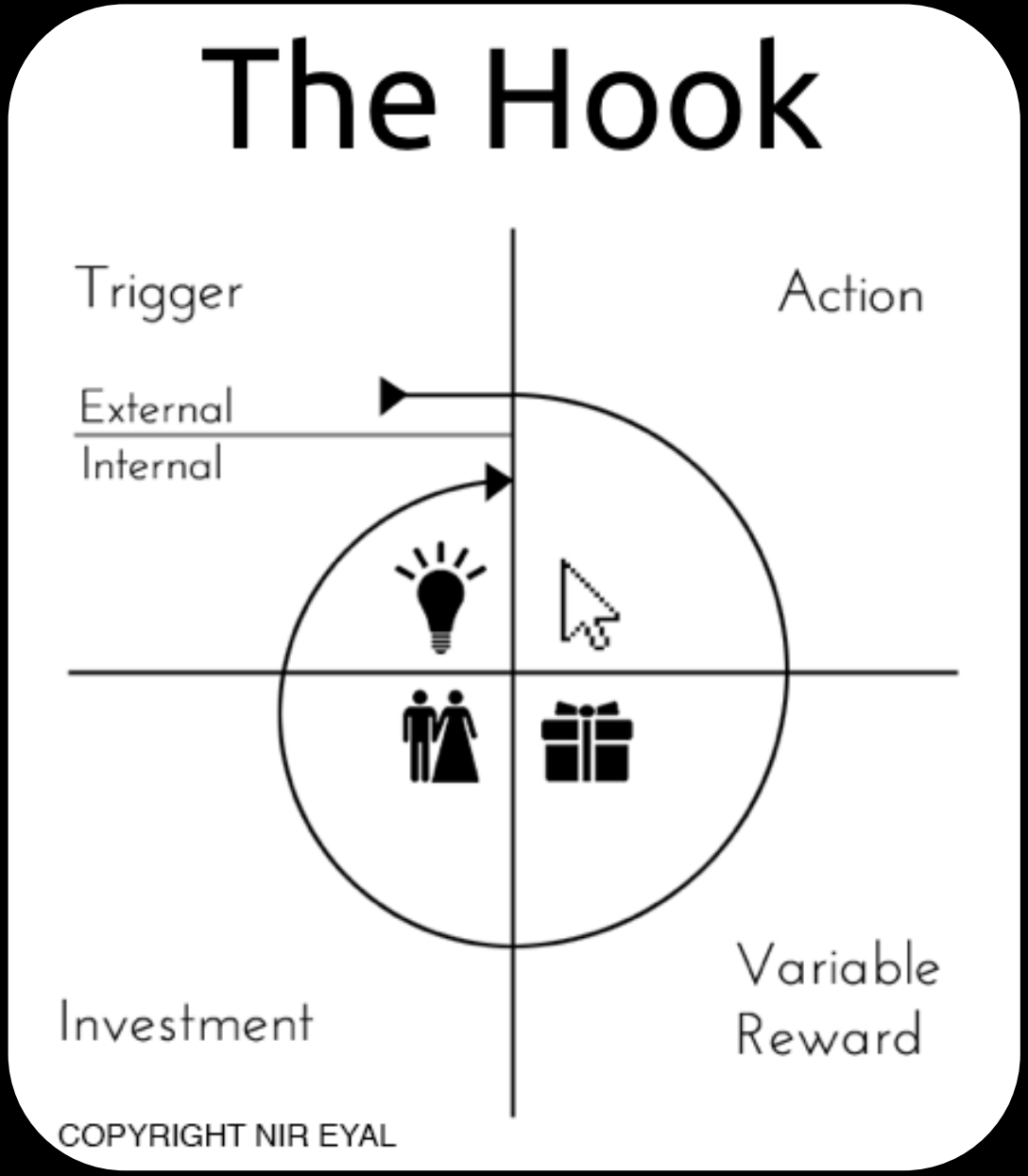




Do interventions have benefits outside the apps they were targeting?

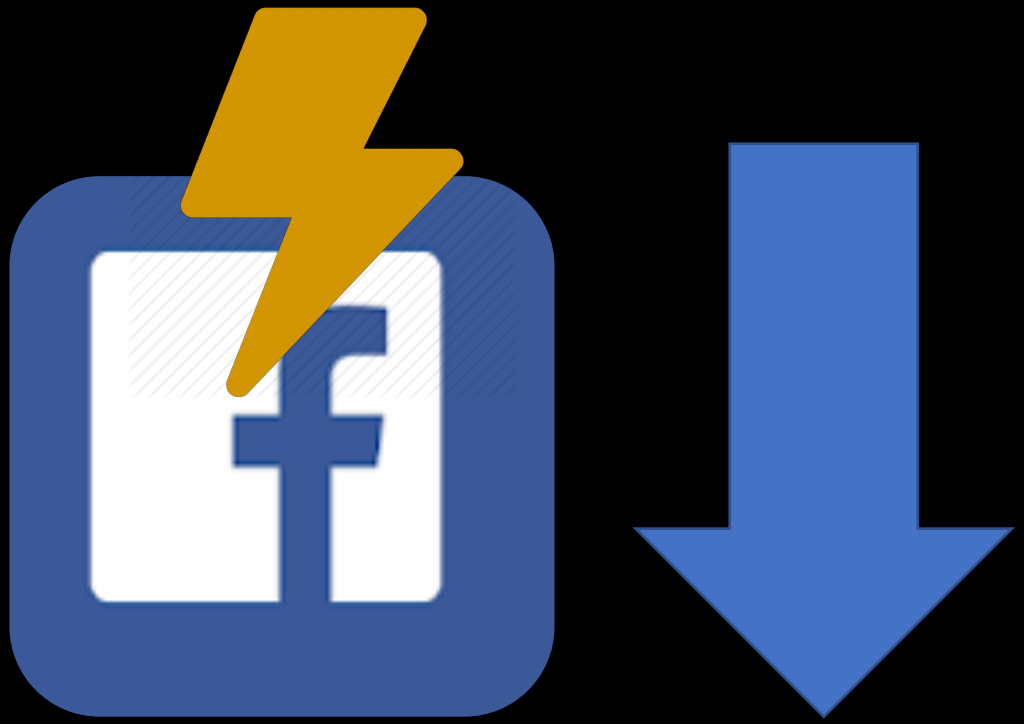
Apps are designed to be habit-building

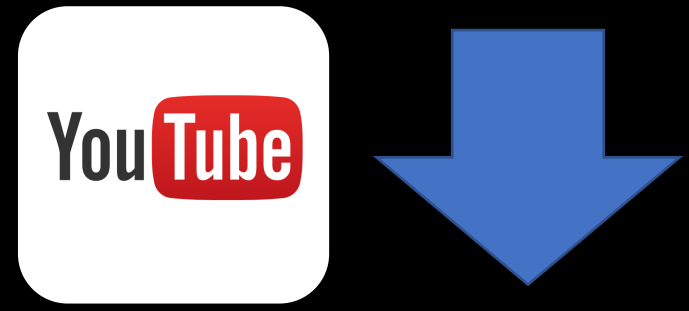
Results in habit loop of constantly visiting sites or checking phones



Does breaking habit loops result in further decreases in time spent elsewhere?

Does reducing time on one app or site **decrease** time on others?





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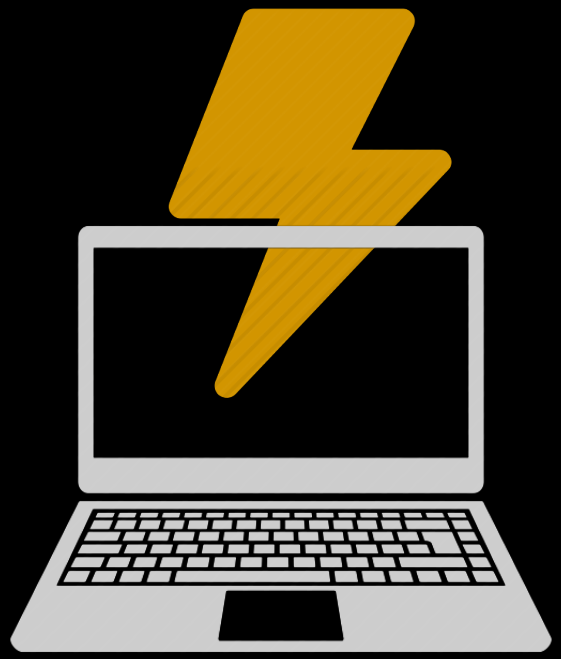

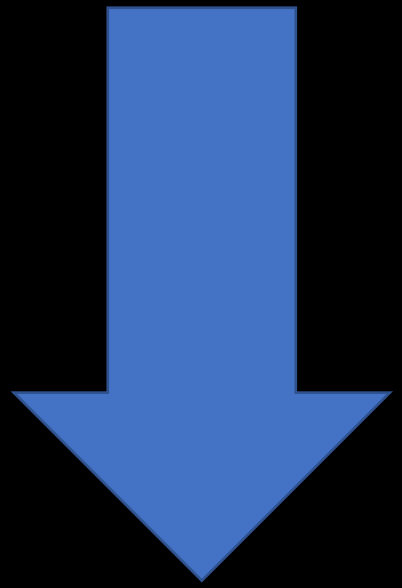

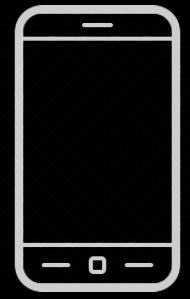

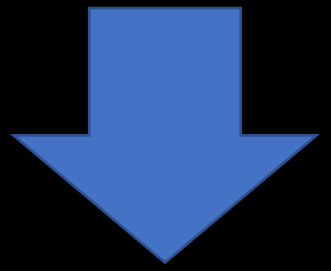

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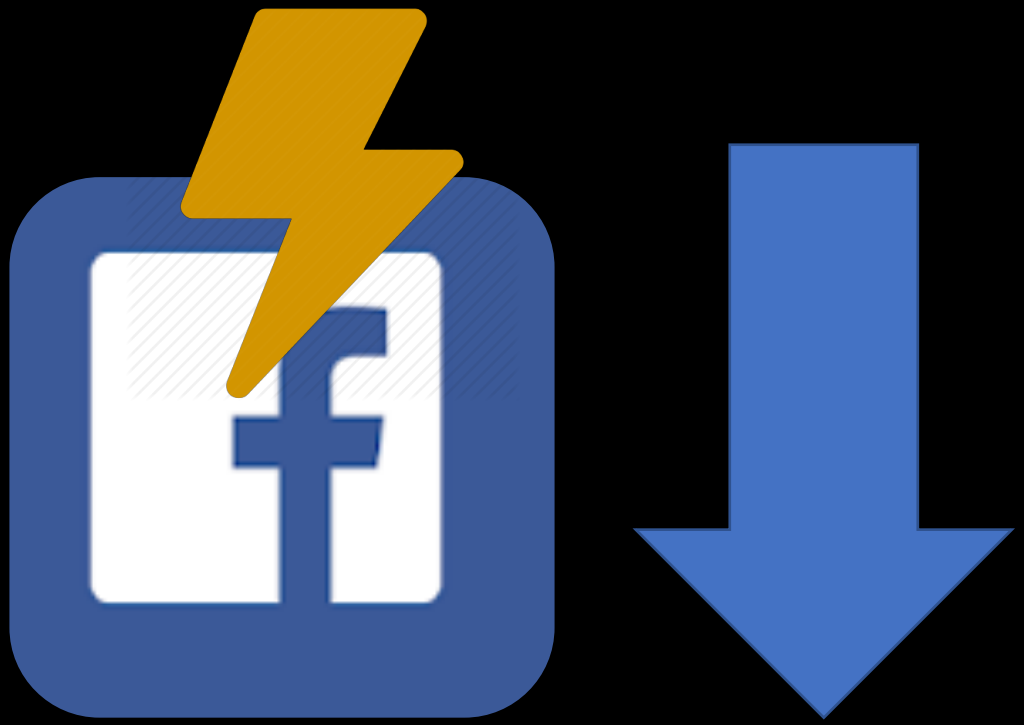

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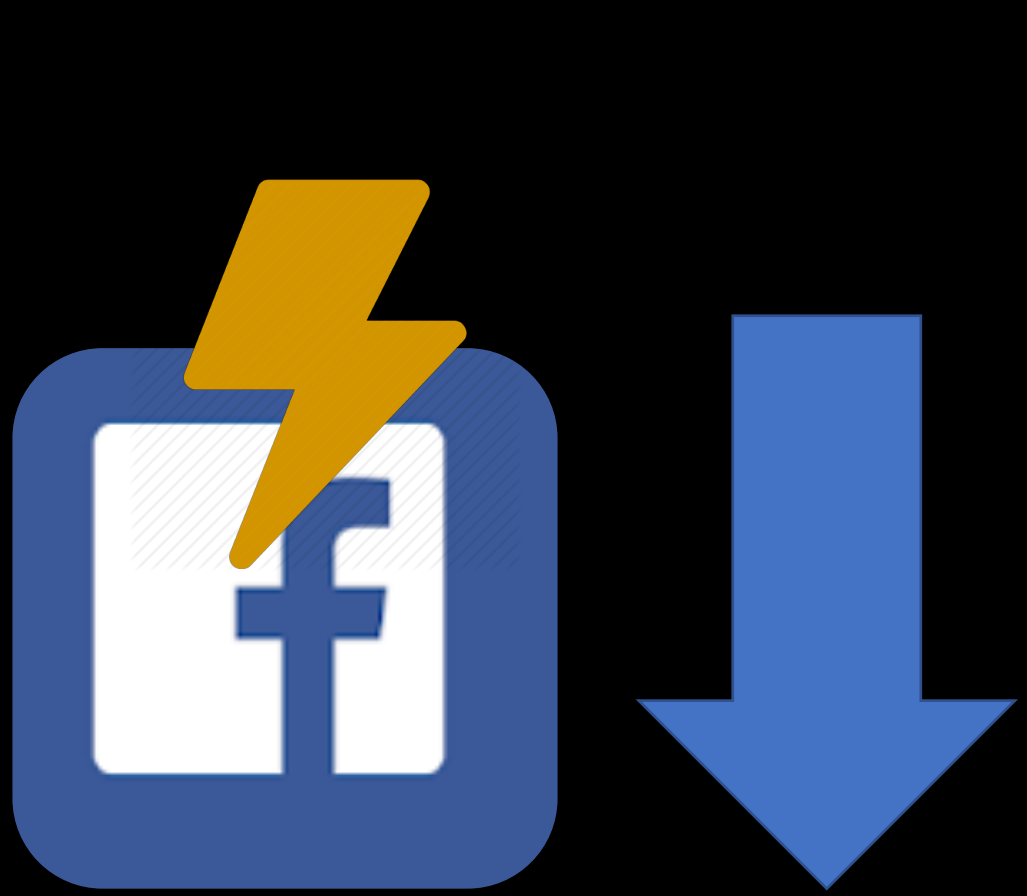
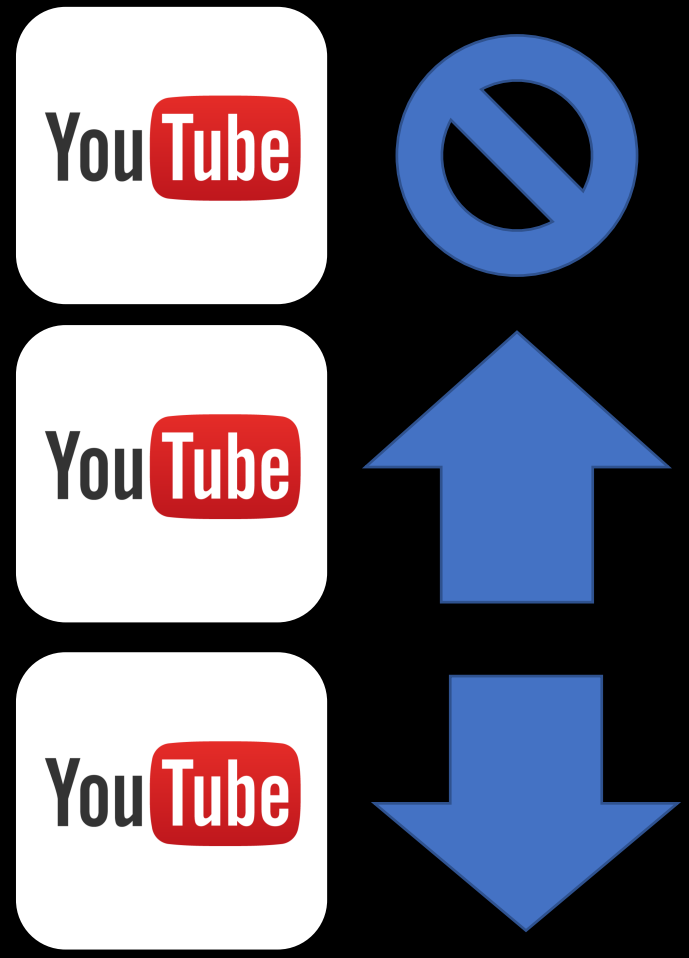


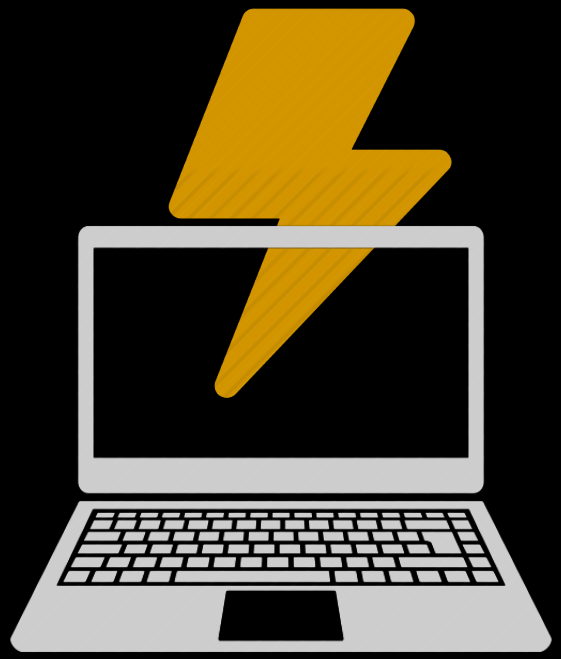
Isolation

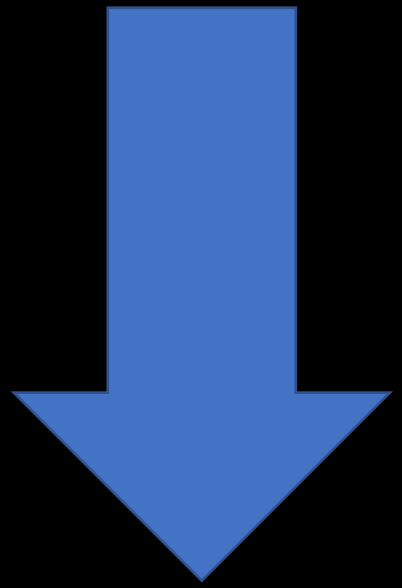
Redistribution

Reduction



RQ2: Do interventions on one device influence time spent on other devices?





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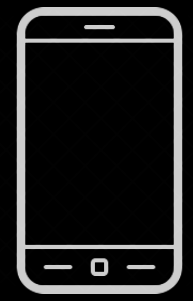

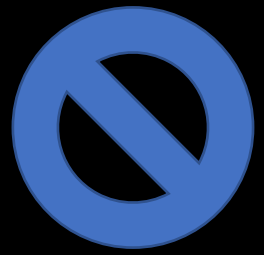

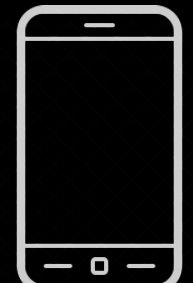

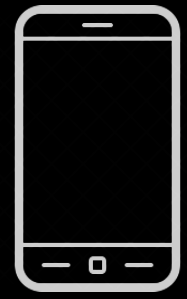

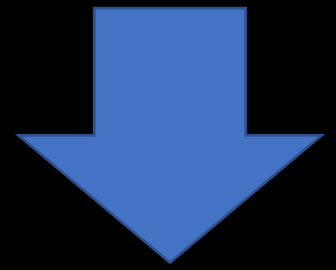

Outline

- **Our behavior change system (HabitLab)**
- Are interventions effective at reducing time on the focal goal?
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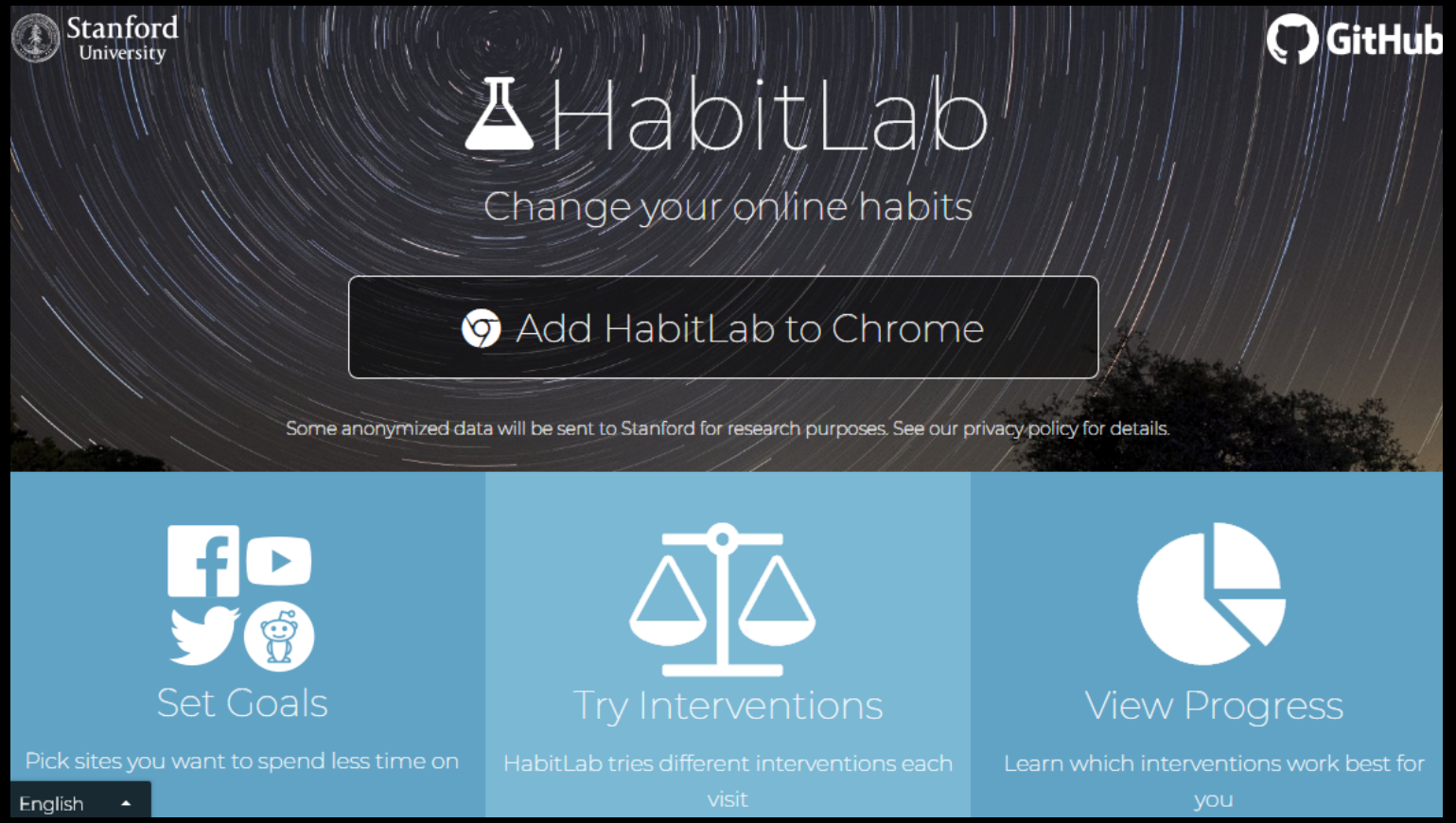
HabitLab

Our behavior change platform

12,000+ in-the-wild active users (Browser+Android)



HabitLab

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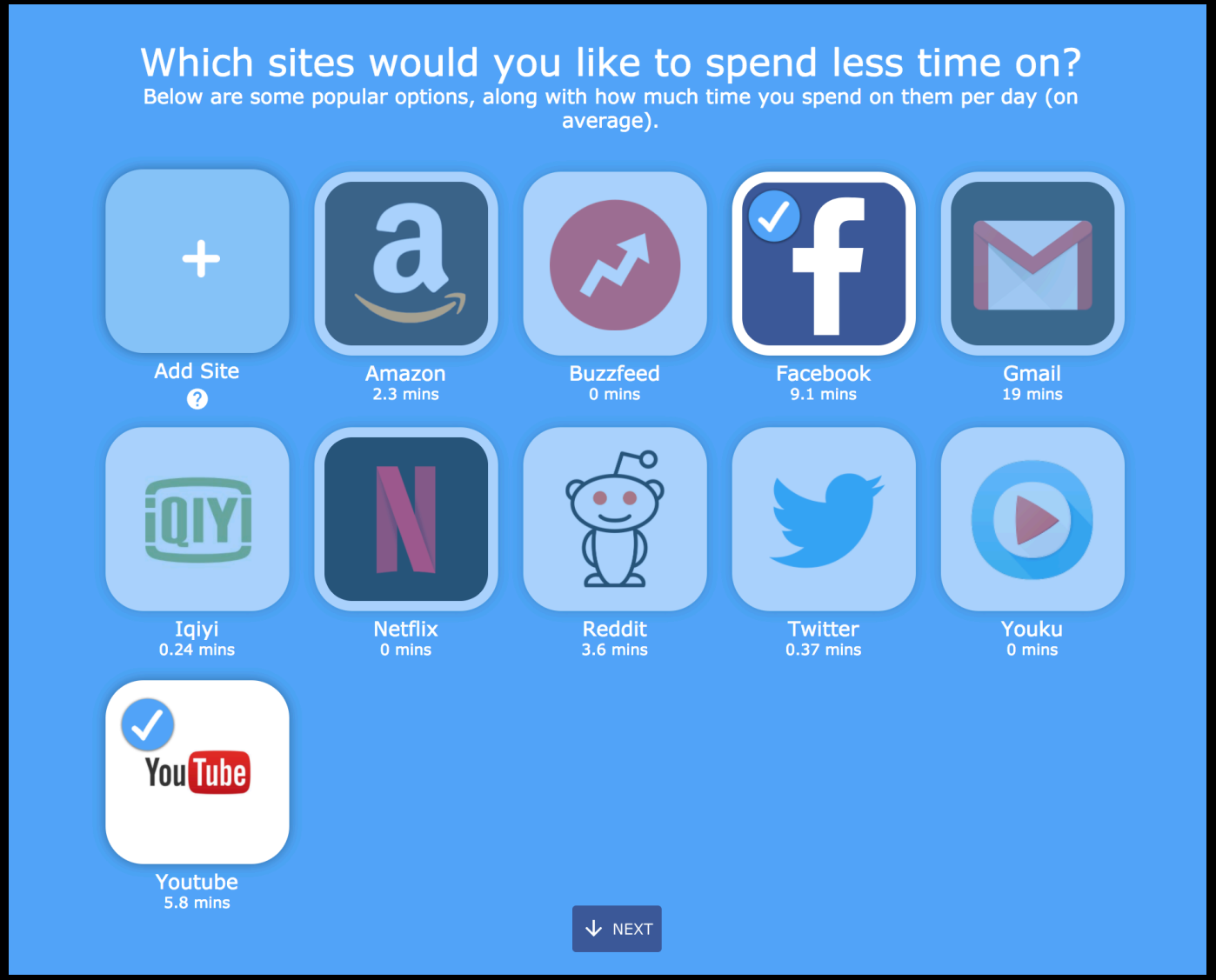
Users select sites or apps to reduce time on (goals)



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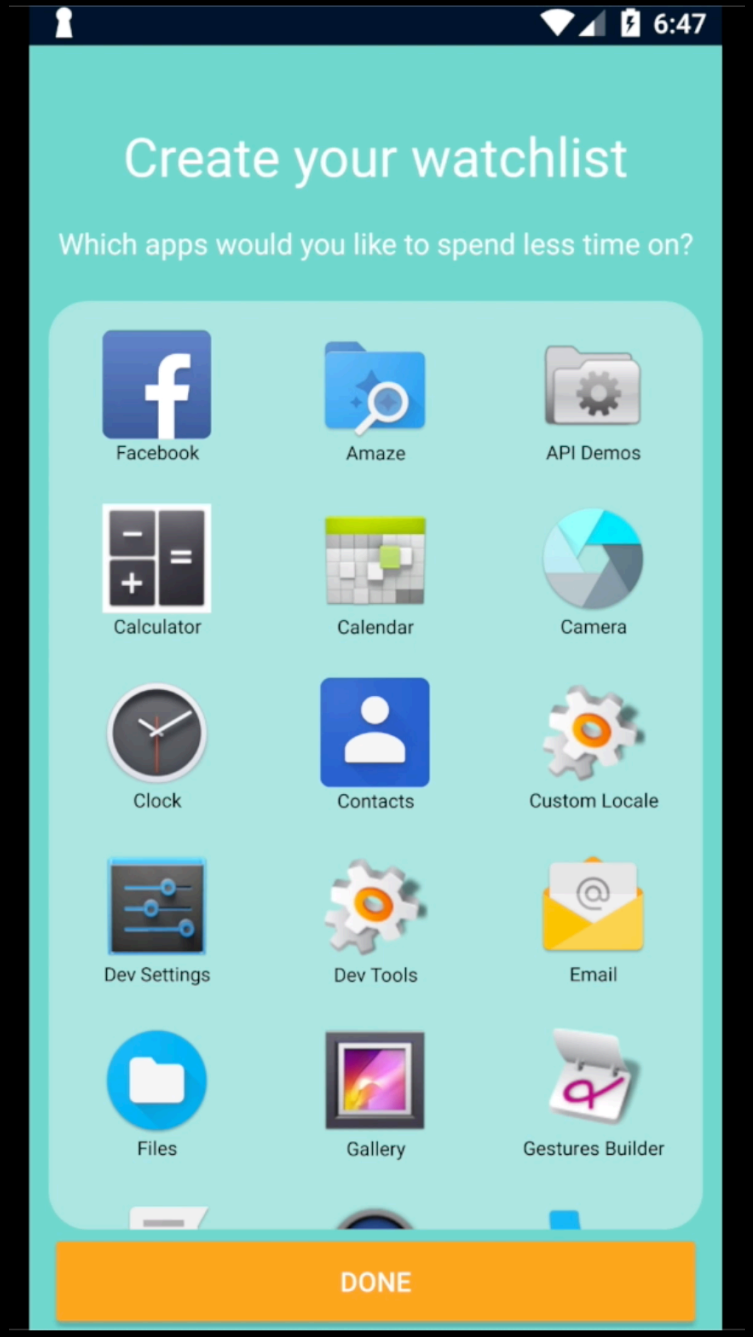
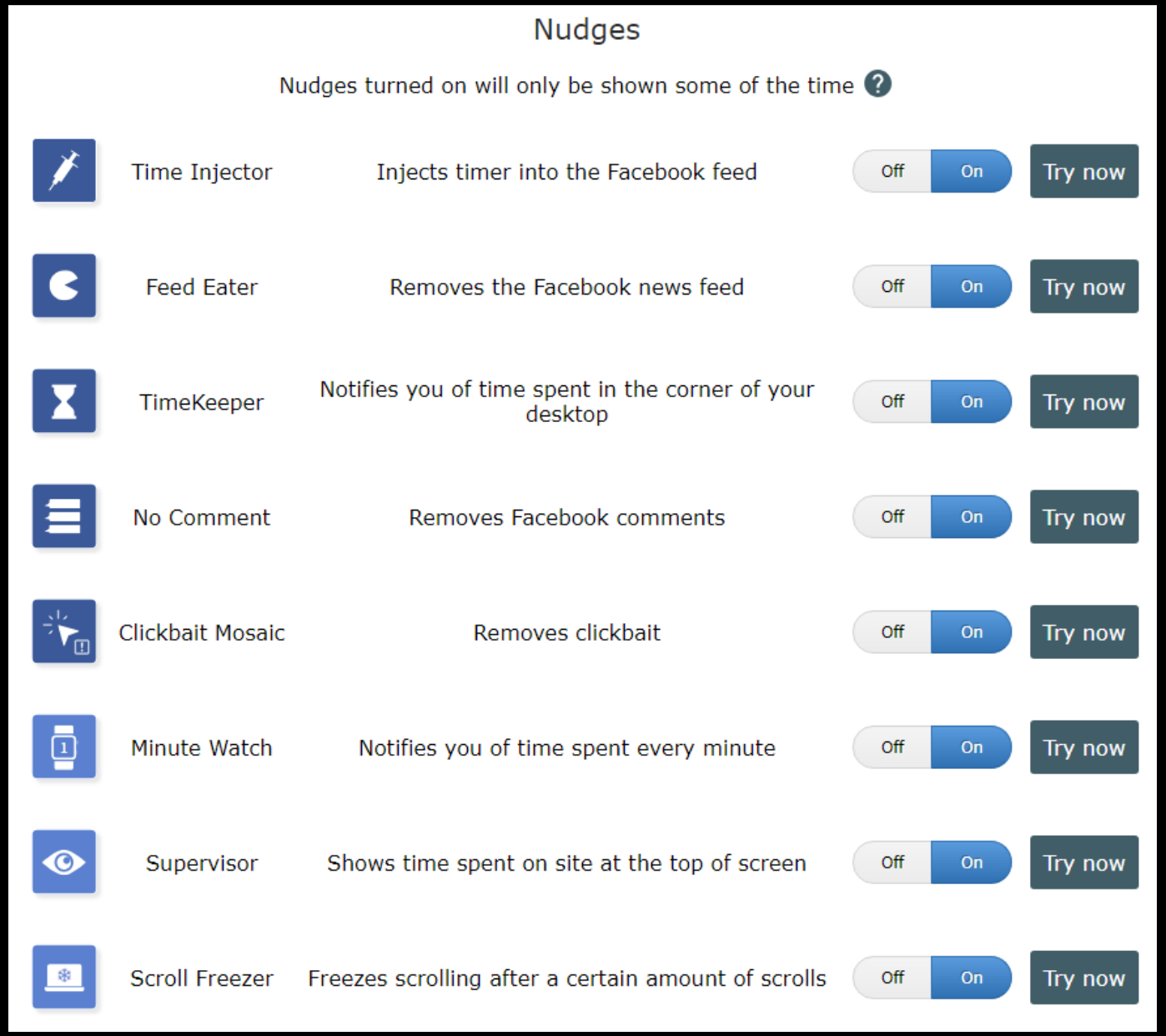


Interventions help reduce time on goal sites and apps

30+ interventions available



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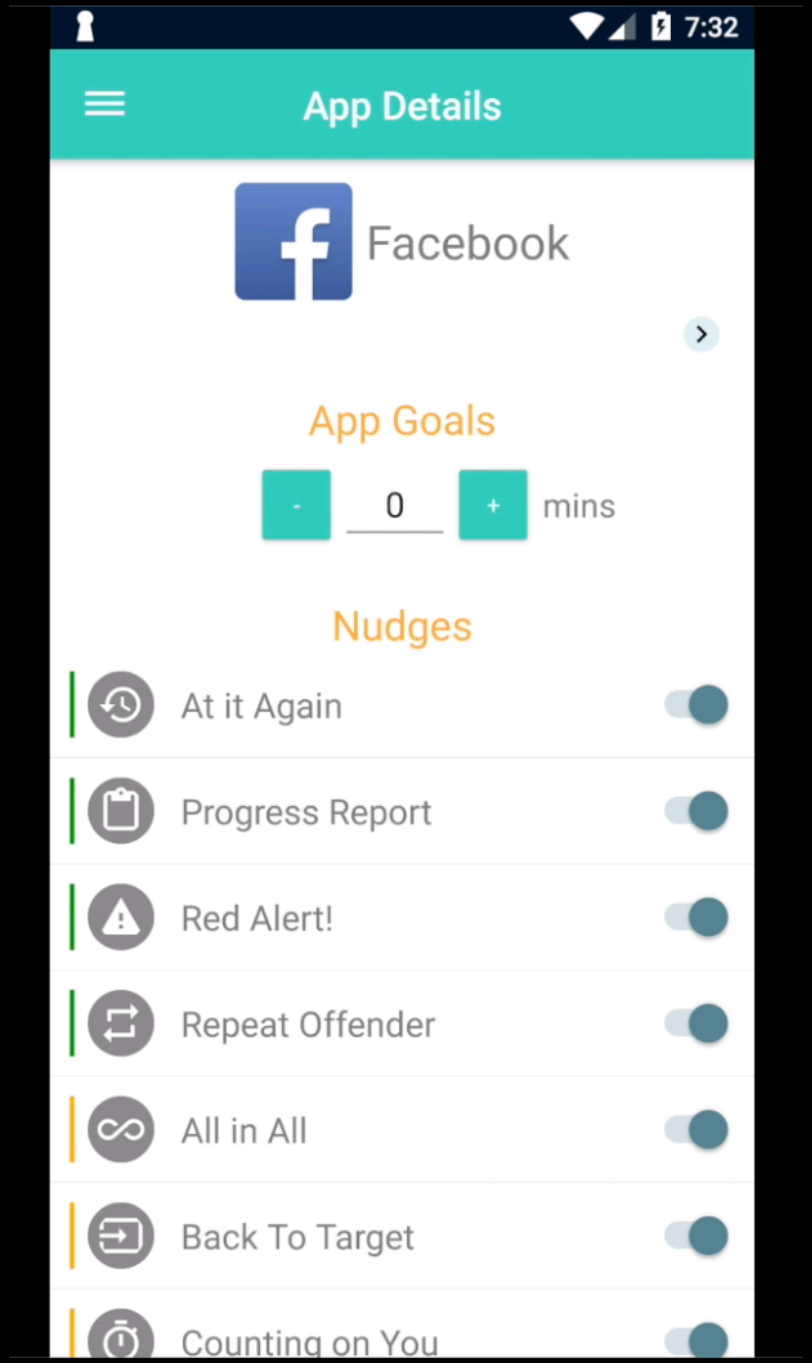
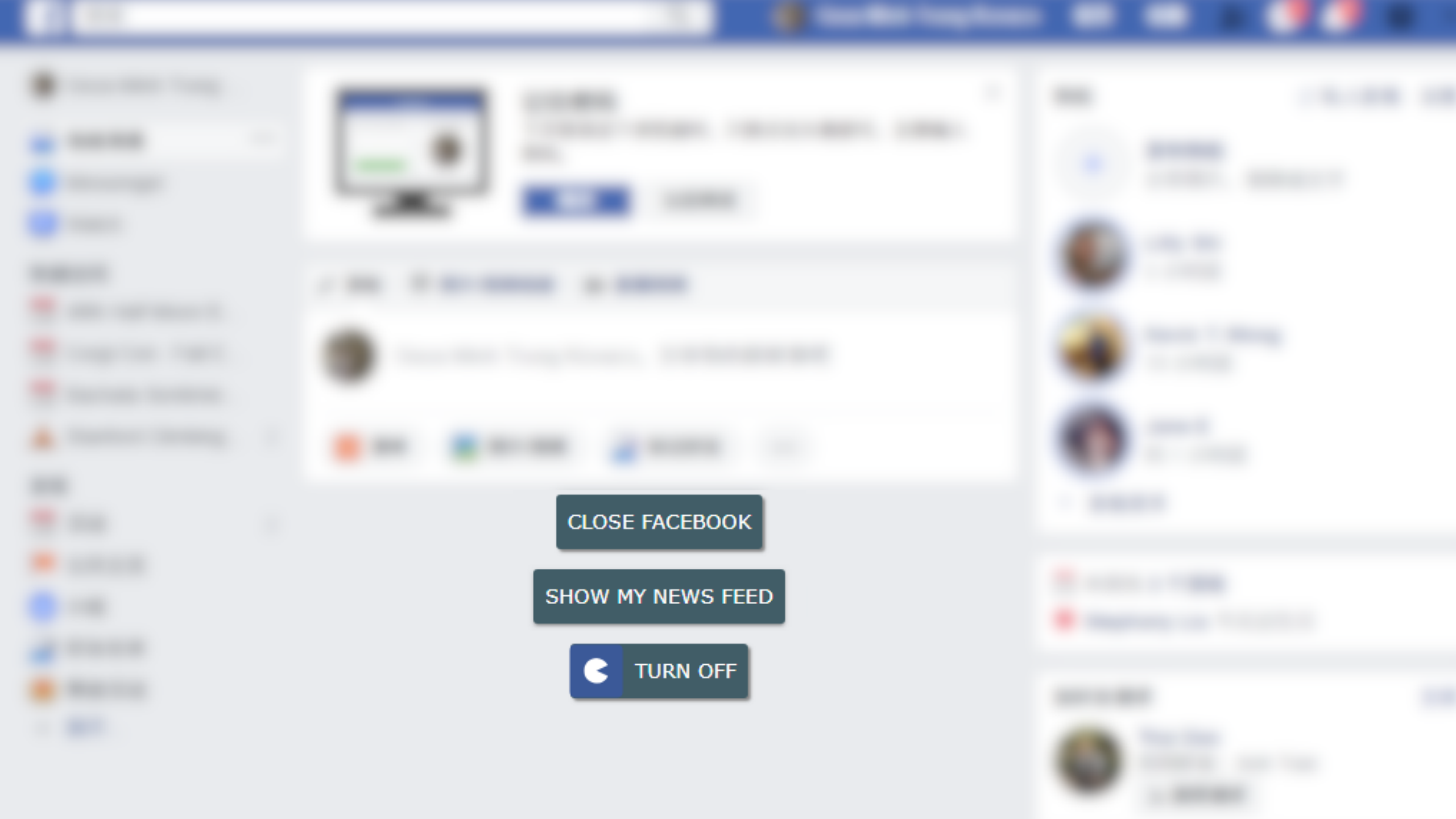



CLOSE FACEBOOK
SHOW MY NEWS FEED
TURN OFF

Today you have been here for:

2 min 38 sec

CLOSE FACEBOOK

TURN OFF

CLOSE TAB

Time remaining:

0 min 42 sec

ADD TIME

Time added:

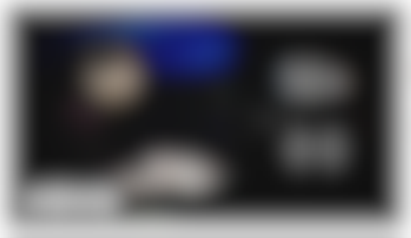
0 min

TURN OFF

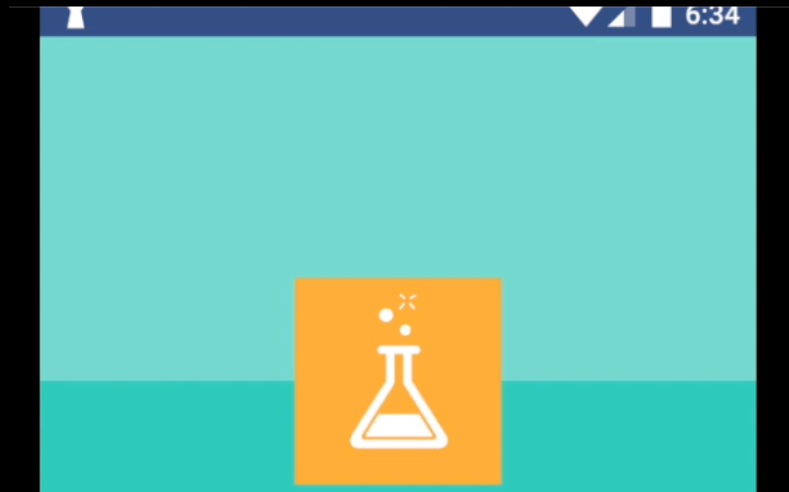
TURN OFF

This video is 3 minutes and 30 seconds long.
Are you sure you want to play it?

CLOSE YOUTUBE WATCH VIDEO



You've opened Facebook 4 times today

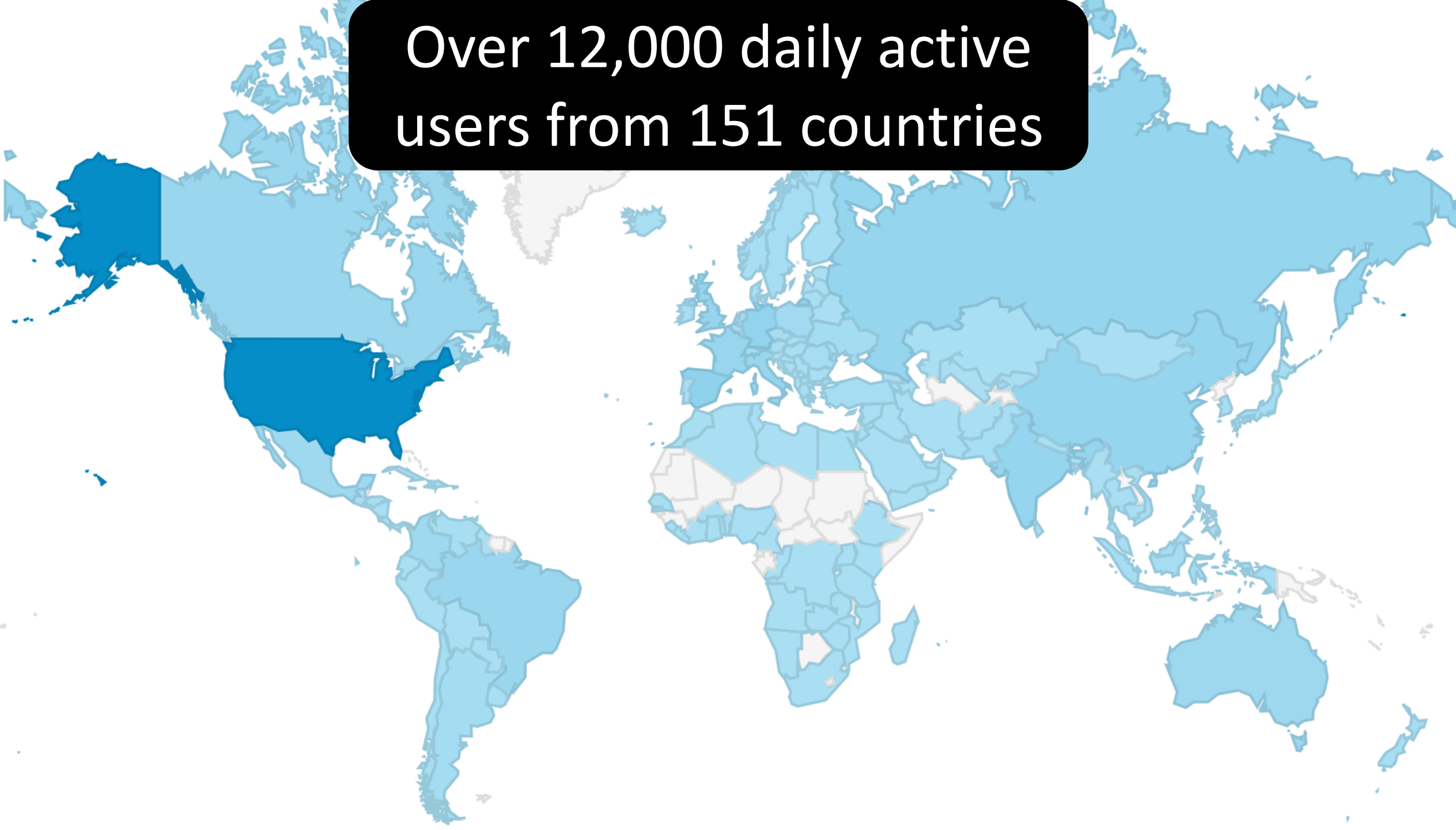


Continue to Facebook?

You've been here 39 times today. Want to take a break?

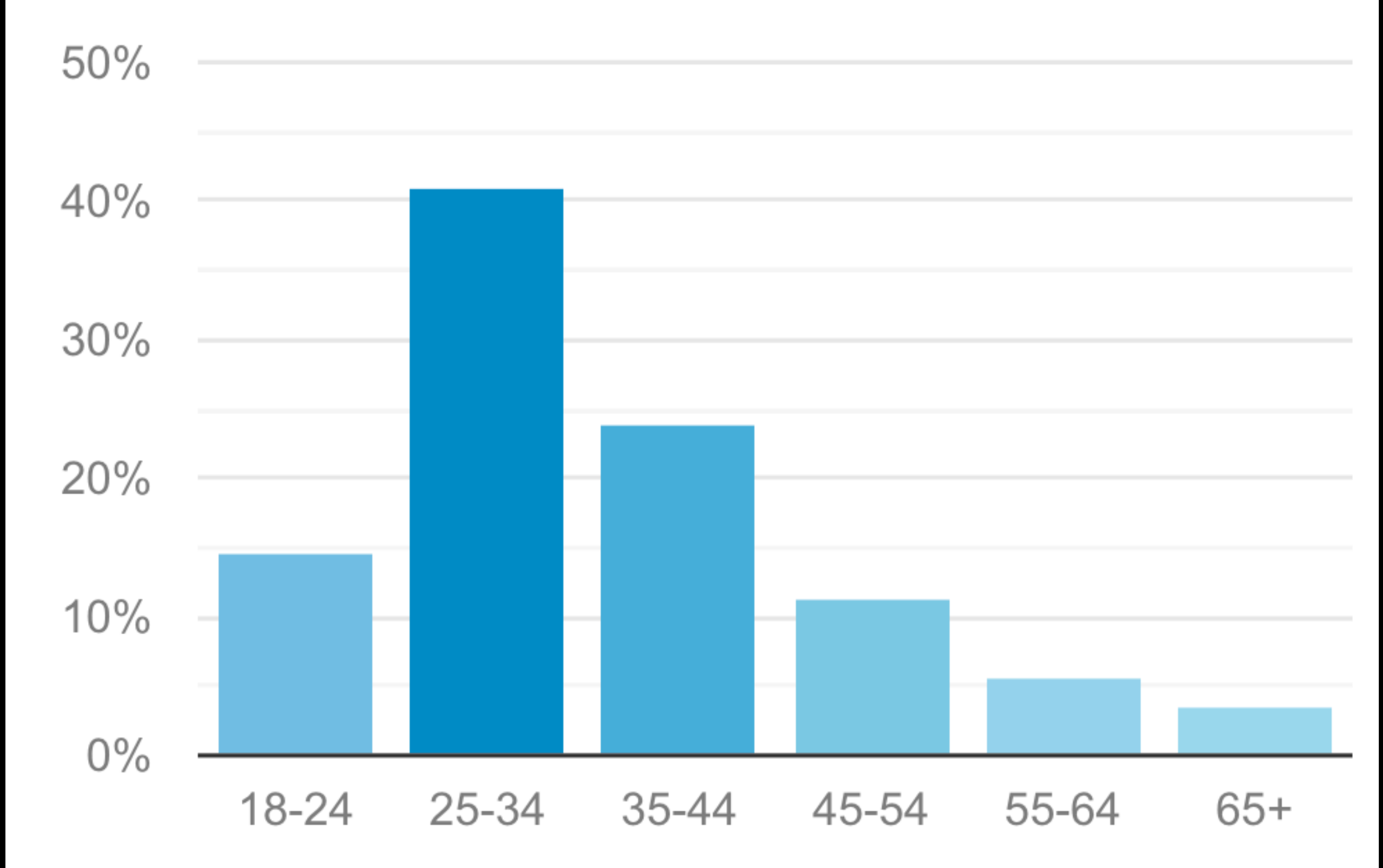
GET ME OUT OF HERE!

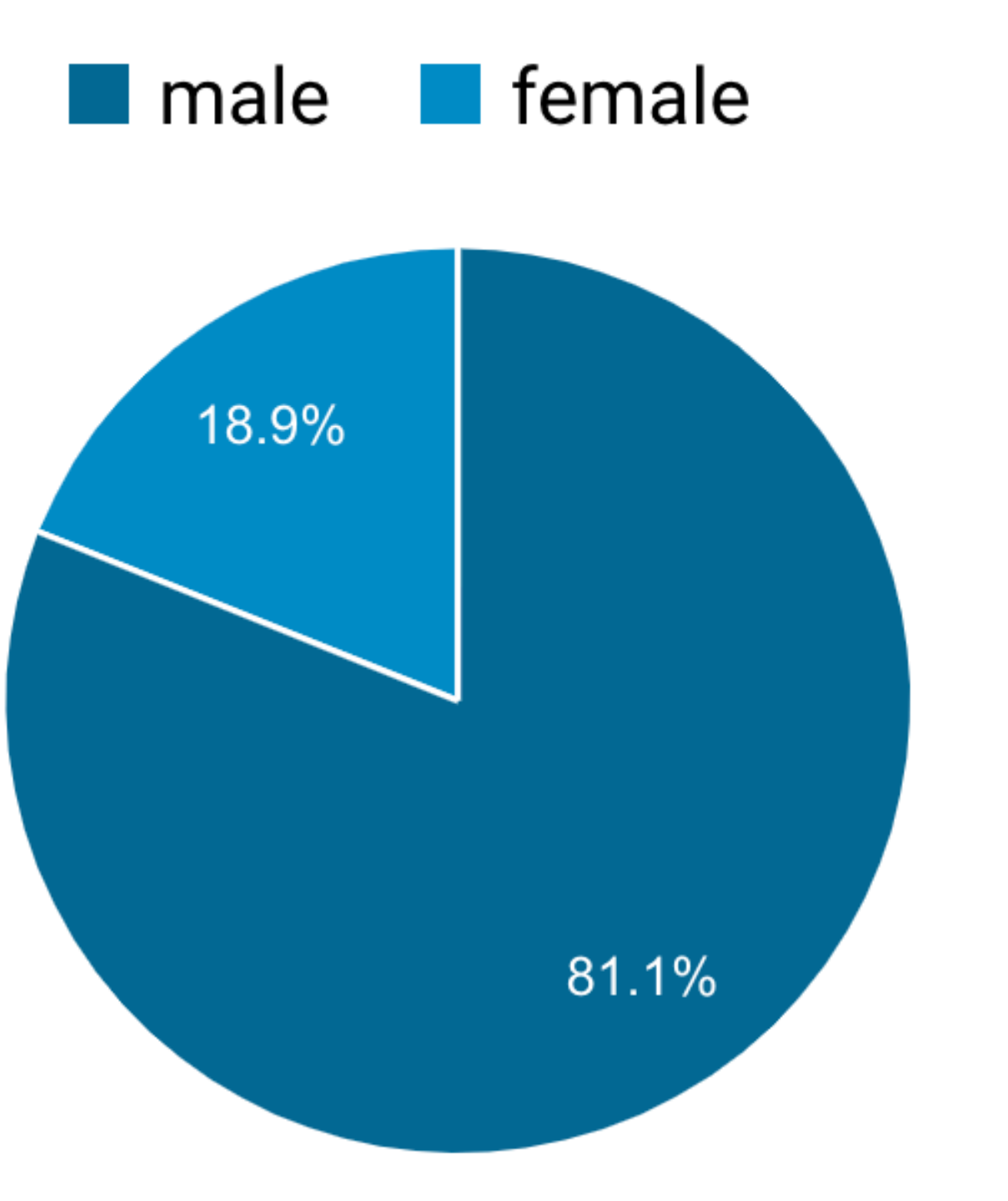
Continue to Facebook


Over 12,000 daily active
users from 151 countries

1.	United States	3,710	30.16%
2.	Spain	605	4.92%
3.	Germany	540	4.39%
4.	Russia	461	3.75%
5.	China	450	3.66%
6.	India	448	3.64%
7.	United Kingdom	439	3.57%
8.	France	418	3.40%
9.	Italy	402	3.27%
10.	Canada	368	2.99%

1.	English (US)	6,143	50.00%
2.	Spanish	801	6.52%
3.	English (UK)	725	5.90%
4.	Chinese (Simplified)	462	3.76%
5.	Russian	443	3.61%
6.	Italian	340	2.77%
7.	Portuguese (Brazil)	293	2.38%
8.	French	289	2.35%
9.	German (Germany)	260	2.12%
10.	German	212	1.73%


50%
40%
30%
20%
10%
0%
18-24
25-34
35-44
45-54
55-64
65+


male
female
18.9%
81.1%

Outline

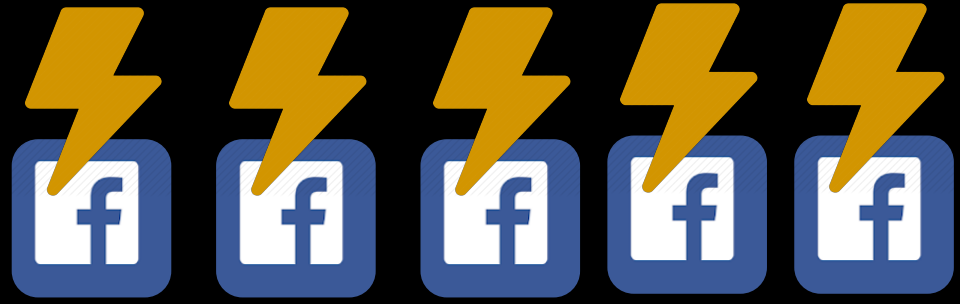
- Our behavior change system (HabitLab)
- **Are interventions effective at reducing time on the focal goal?**
- RQ1: Is time redistributed to other sites on the same platform?
- RQ2: Is time redistributed across devices?

Are interventions effective? (Method)

For each goal, we randomly assign it to one of 2 conditions each week:

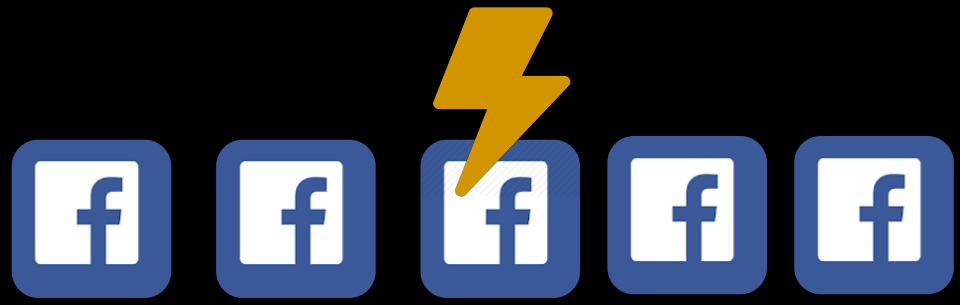
Frequent

An intervention is shown every visit
(each site visit for browser, each app visit on android)



Infrequent

An intervention is shown on 20% of visits



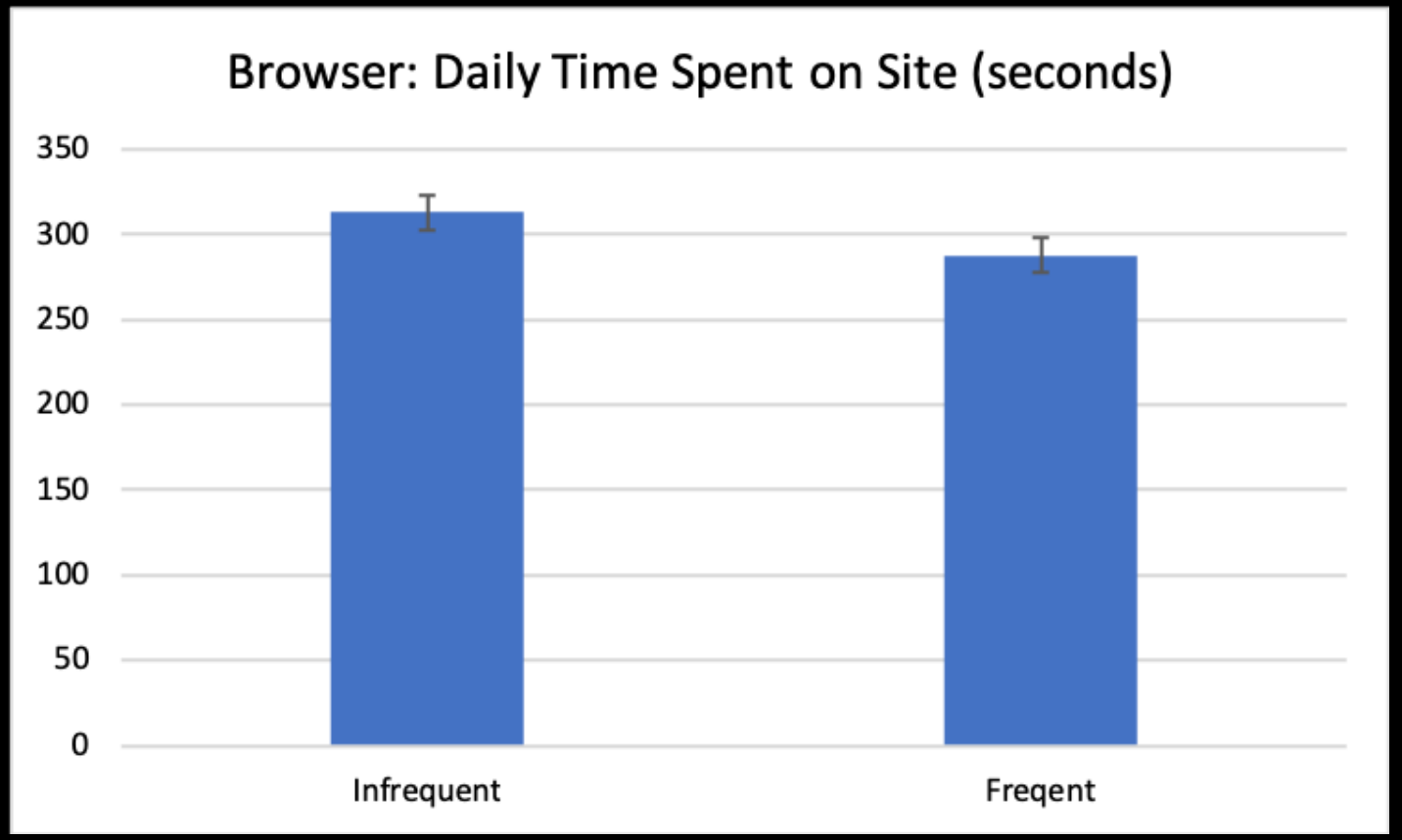
Are interventions effective? (Method)

- Compare daily time spent on days in the frequent vs infrequent conditions, for each goal

Are interventions effective? (Method)

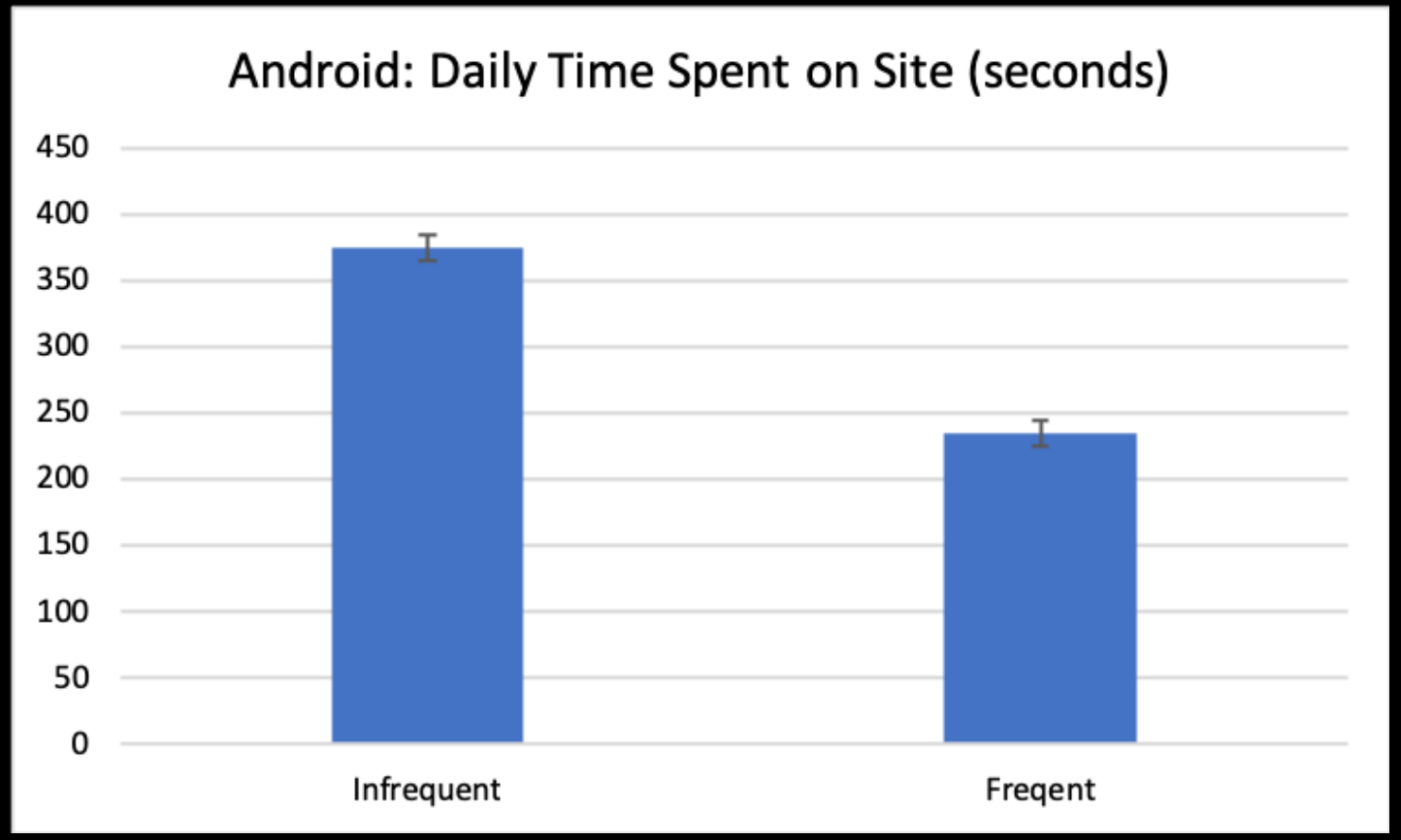
- Compare daily time spent on days in the frequent vs infrequent conditions, for each goal
- 5.8 weeks with 1034 users on browser (n=22,462 days), and 876 users on mobile (n=26,273 days)

Interventions are effective on both platforms



7.3% reduction in daily time spent on browser version, on frequent weeks. Statistically significant ($p < 0.001$)

Interventions are effective on both platforms



37.2% reduction in daily time spent on android version, on frequent weeks. Statistically significant ($p < 0.001$)

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  - **Effective on both browser and mobile**
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- Our behavior change system (HabitLab)
- Are interventions effective at reducing time on the focal goal?
  - Effective on both Browser and Android
- **RQ1: Is time redistributed to other sites on the same platform?**
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Is time redistributed within platform? (Method)

We developed a metric of how intense interventions are this day (**intensity**)

- Percentage of sessions on a goal that triggered an intervention

Is time redistributed within platform? (Method)

We developed a metric of how intense interventions are this day (**intensity**)

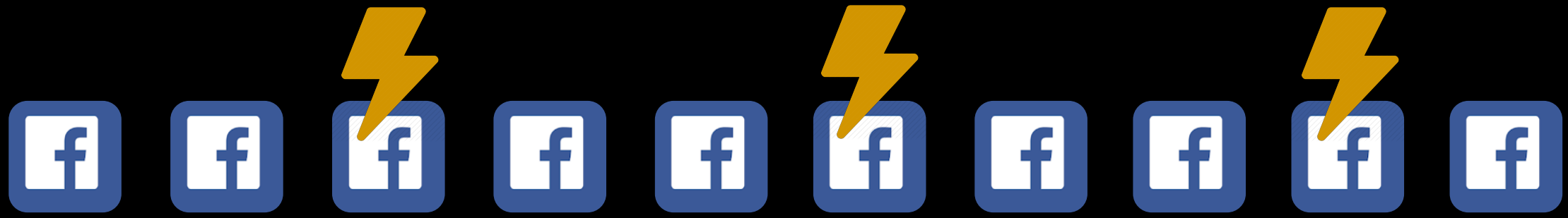
- Percentage of sessions on a goal that triggered an intervention.
- E.g. if visited Facebook 10x, and saw 0 interventions, then intensity=0

Intensity=0

Is time redistributed within platform? (Method)

We developed a metric of how intense interventions are this day (**intensity**)

- Percentage of sessions on a goal that triggered an intervention.
- E.g. if visited Facebook 10x, and saw 3 interventions, then intensity=0.3

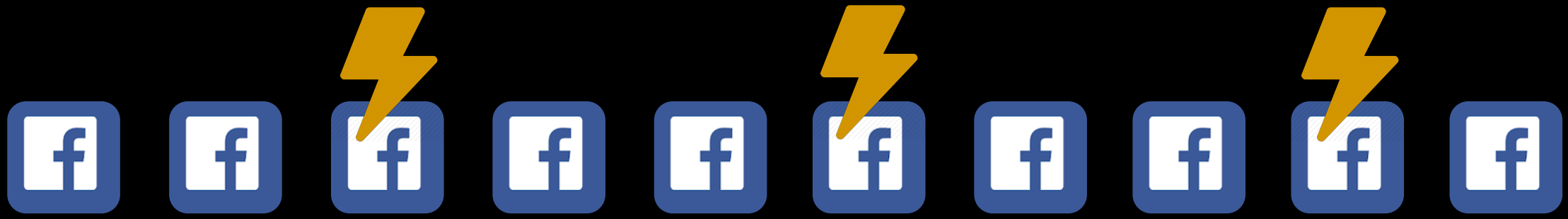


Intensity=0.3

Is time redistributed within platform? (Method)

We developed a metric of how intense interventions are this day (**intensity**)

- Percentage of sessions on a goal that triggered an intervention.
- Verified that on days where intensity is higher, overall total time on goal sites is significantly lower on both platforms



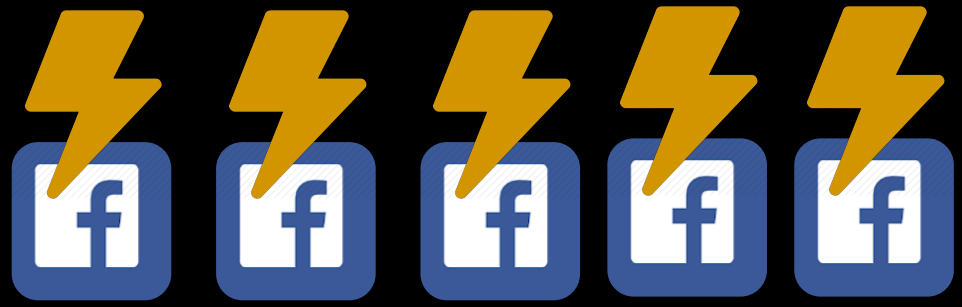
Intensity=0.3

Is time redistributed within platform? (Method)

To manipulate intensity, we randomly assign each goal to have either frequent or infrequent interventions each week, resulting in a continuous intensity value from 0 to 1

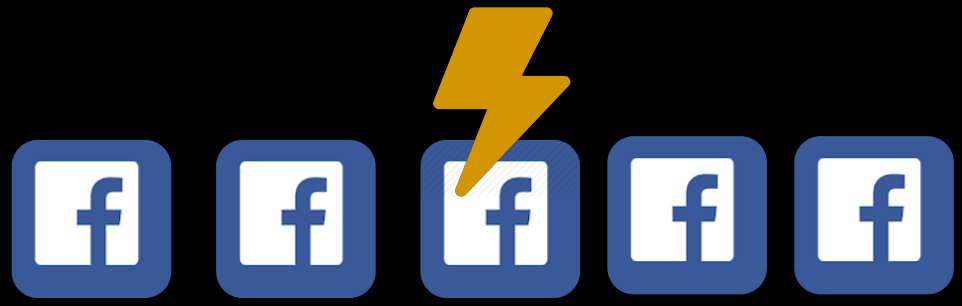
Frequent

An intervention is shown every visit
(each site visit for browser, each app visit on android)



Infrequent

An intervention is shown on 20% of visits

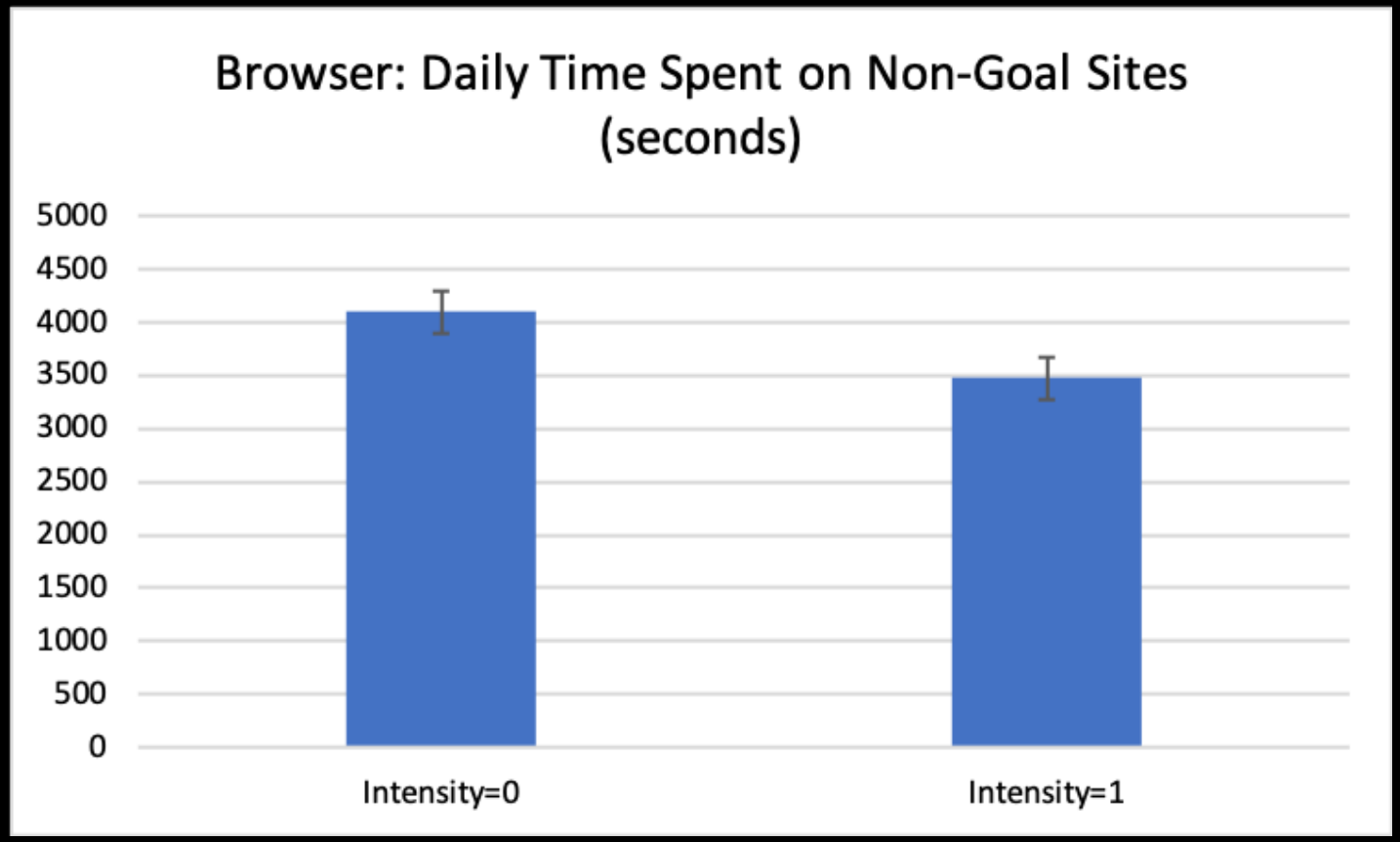


Is time redistributed within platform? (Method)

On days when intensity is higher, what is the effect on the time spent on non-goal apps and sites?

LMM (Linear Mixed Model) structure	
Dependent variable	Total time on non-goal sites (log)
Fixed effects	Intensity
Random effects	User

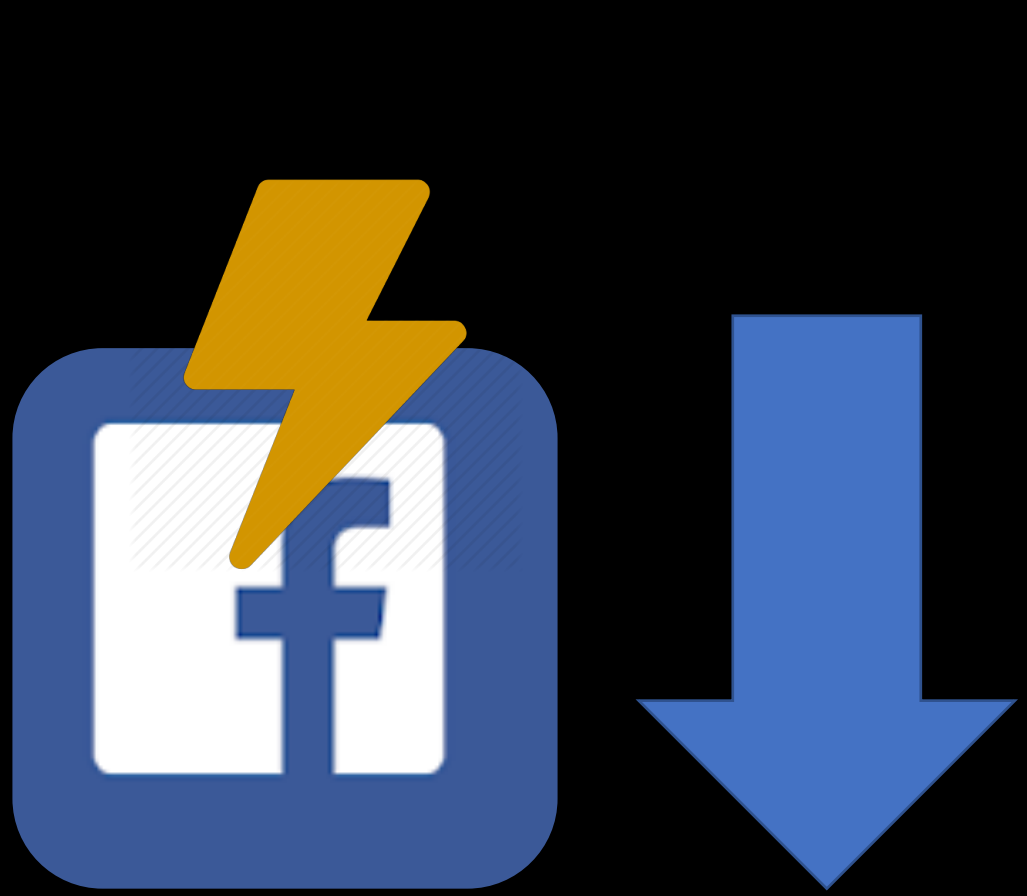
Browser: **reduction** of time spent on other sites when intensity is higher



15% reduction in time spent when intensity increases from 0→1 ($p < 0.0001$)

Mobile: No significant effect of time on one app on other apps

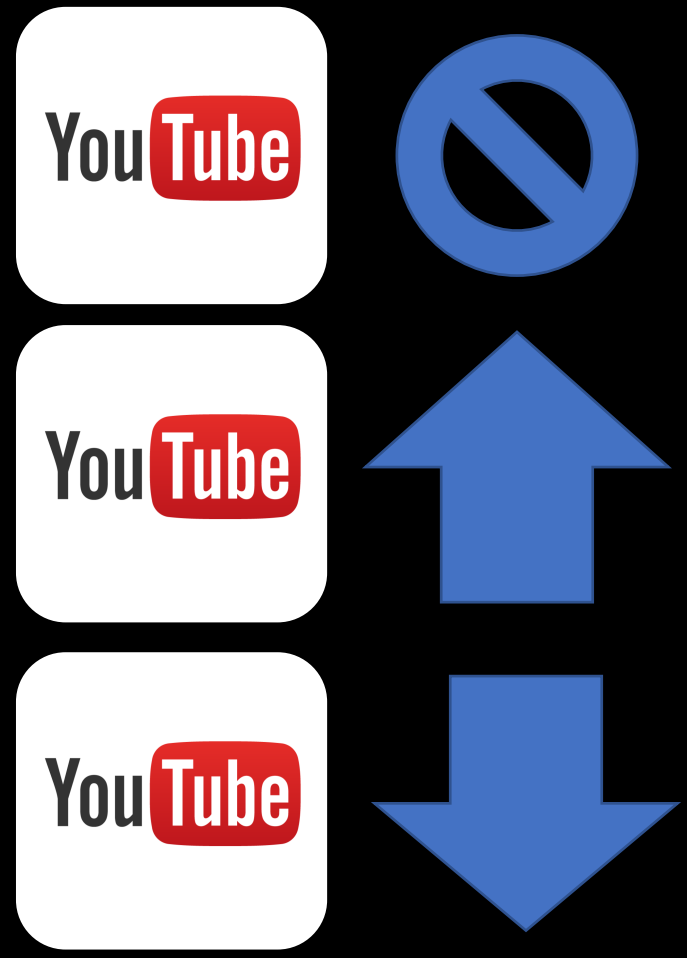
RQ1: Do interventions on one site/app influence time spent on other sites/apps?



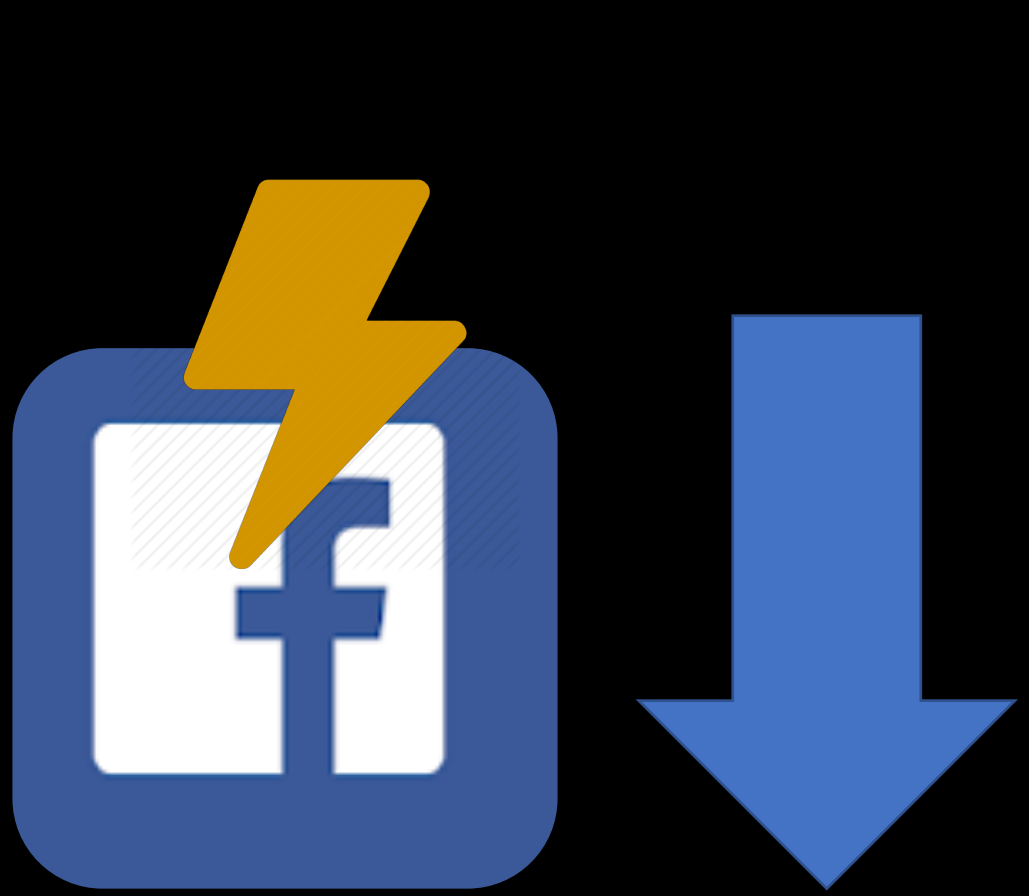
Isolation

Conservation

Reduction



RQ1: Do interventions on one site/app influence time spent on other sites/apps?



Isolation

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Browser

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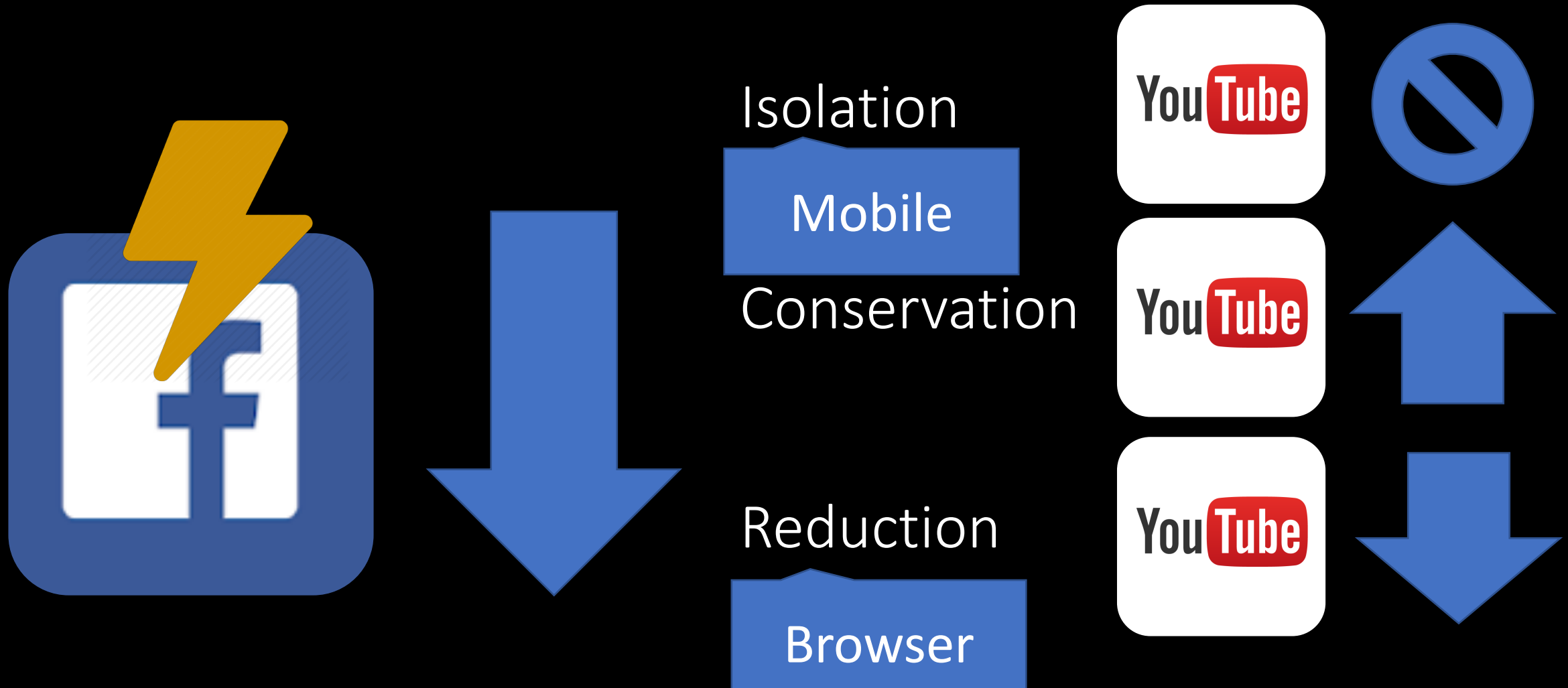
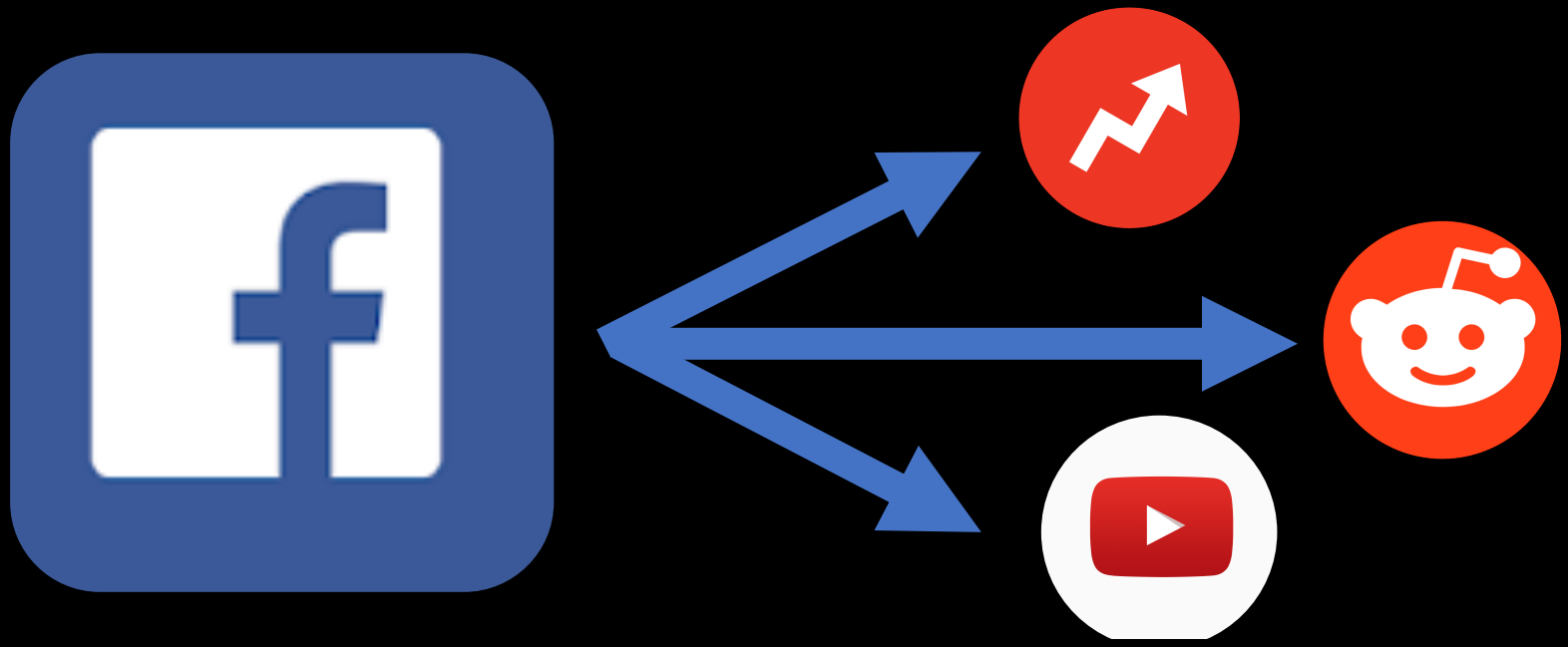


Why was there a reduction effect on browser?

Aggregator sites such as Facebook often link to other domains

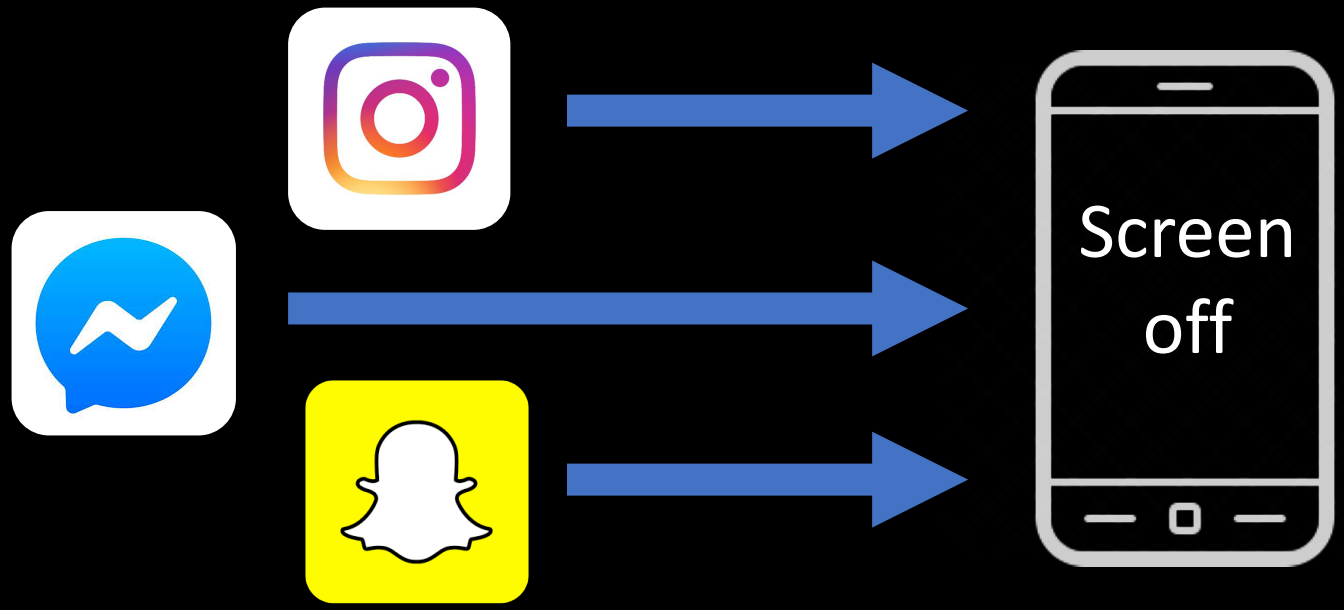
By reducing visits and time on Facebook, we reduce time on other domains



Why was there no effect on mobile?

Mobile goal apps were mostly messaging-oriented, not aggregators

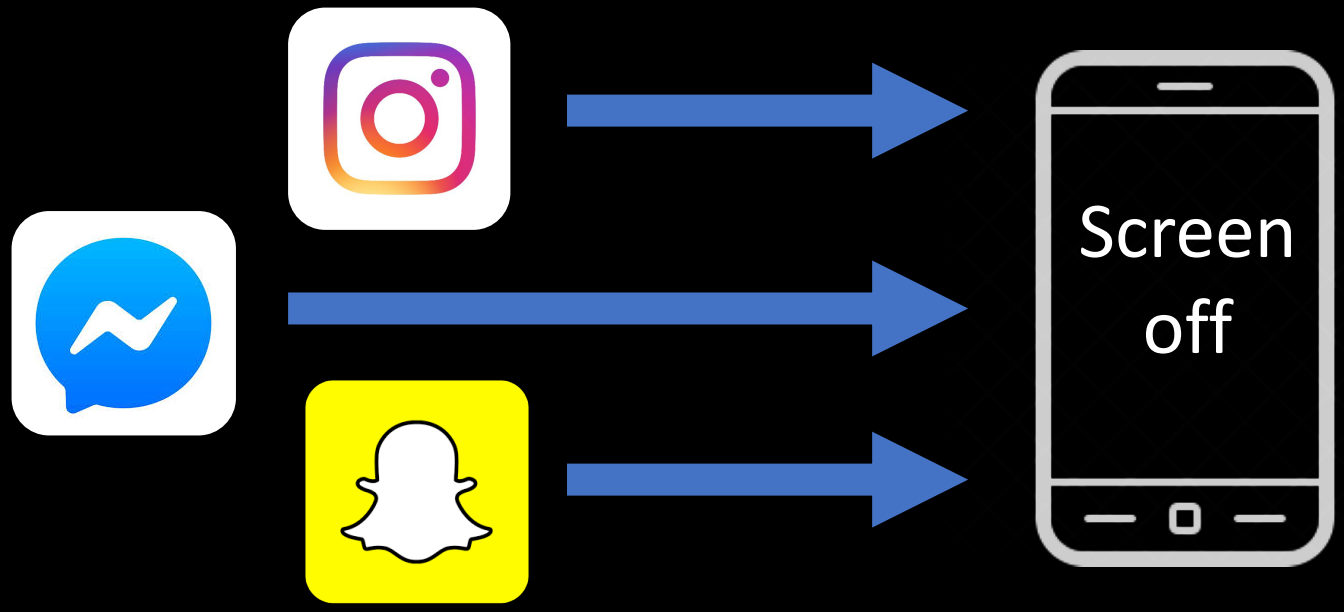
Sessions were short and followed by turning off the screen



Oulasvirta, Antti, et al. "Interaction in 4-second bursts: the fragmented nature of attentional resources in mobile HCI." *Proceedings of the SIGCHI conference on Human factors in computing systems*. ACM, 2005.

Why was there no effect on mobile?

Many mobile apps such as Facebook embed an in-app browser, so visiting external links remains within the same app



Outline

- Our behavior change system (HabitLab)
- Are interventions effective at reducing time on the focal goal?
  - Effective on both browser and mobile
- RQ1: Is time redistributed to other sites on the same platform?
  - **Reducing time on one site reduces time elsewhere on browser (reduction hypothesis), but not mobile (isolation hypothesis)**
- RQ2: Is time redistributed across devices?

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Is time redistributed across devices? (Method)

- On days when intensity is higher on one device, what is the effect on total time spent on goal sites on the other device?

Is time redistributed across devices? (Method)

- On days when intensity is higher on one device, what is the effect on total time spent on goal sites on the other device?
- Limited to participants using HabitLab on both platforms (60 participants, n=429 days)

Is time redistributed across devices? (Method)

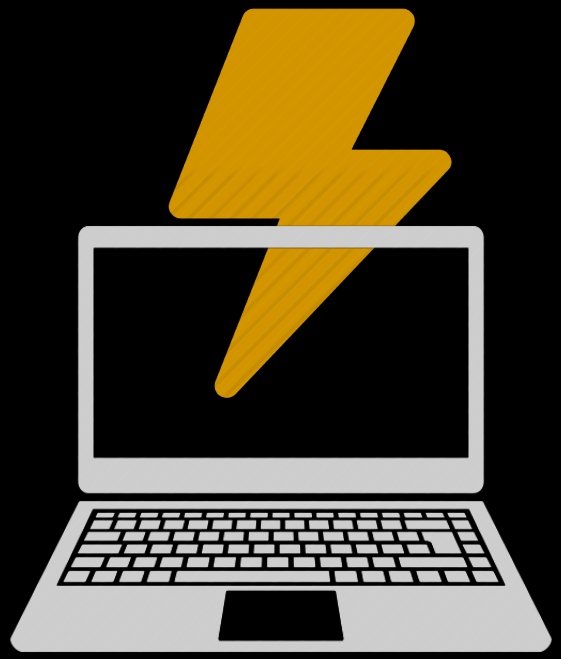
- On days when intensity is higher on one device, what is the effect on total time spent on goal sites on the other device?
- Limited to participants using HabitLab on both platforms (60 participants, n=429 days)

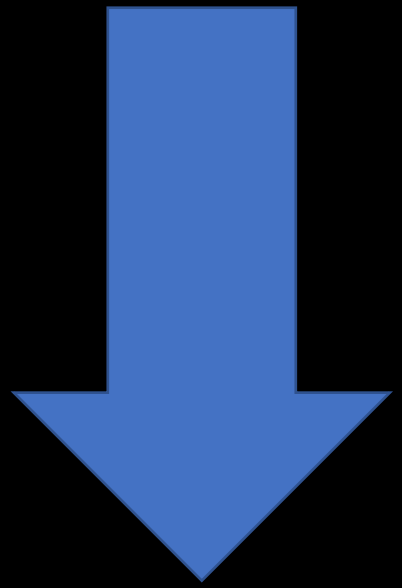
LMM (Linear Mixed Model) structure	
Dependent variable	Total time on other device (log)
Fixed effects	Intensity on this device
Random effects	User

Time is not redistributed across devices

- Effects of browser intensity on mobile: No significant effect ($p>.5$)
- Effects of mobile intensity on browser: No significant effect ($p>.5$)

RQ2: Do interventions on one device influence time spent on other devices?

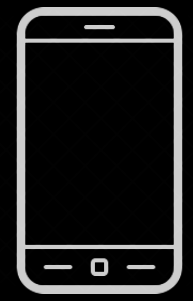


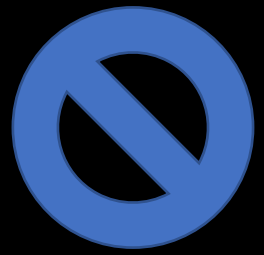


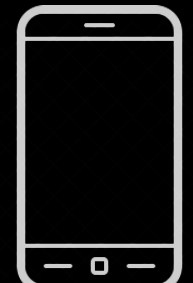
Isolation

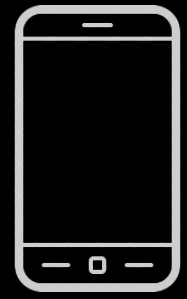
Redistribution

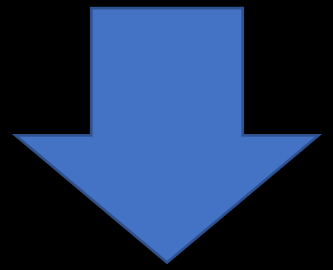
Reduction



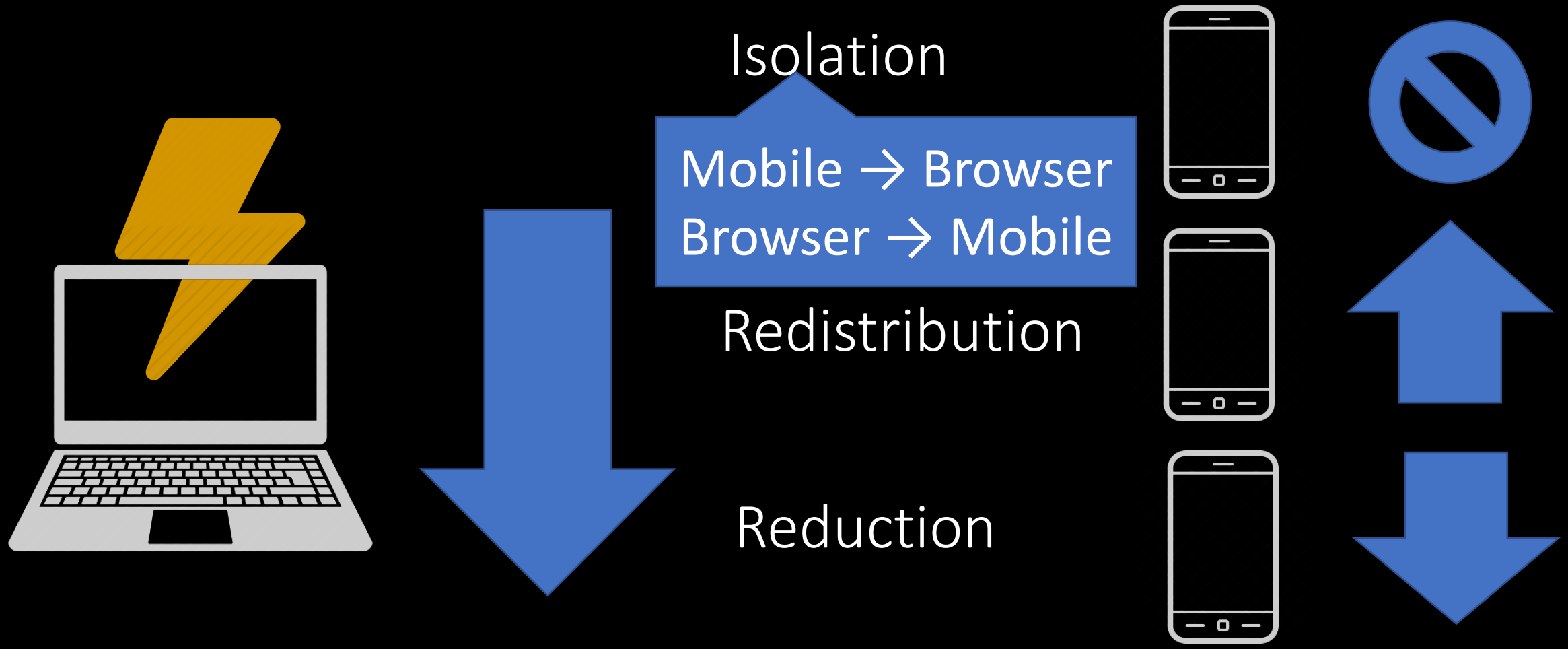






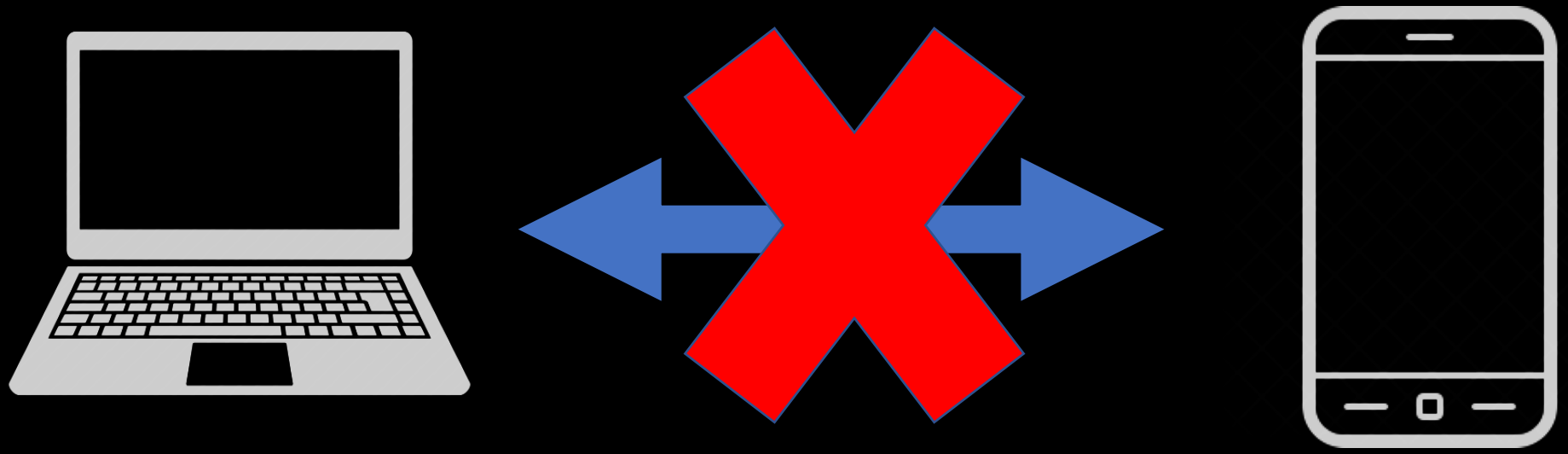


RQ2: Do interventions on one device influence time spent on other devices?



Why were there no cross-device effects?

- Laptops and phones are used in different contexts
- Unlike browsers, there are no cross-device “links” – few apps/sites prompt you to start using the other device



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- RQ2: Is time redistributed across devices?
  - **Time is not redistributed across devices (isolation hypothesis)**

Discussion and implications

- We did not observe negative secondary effects of productivity interventions (on other apps, sites, or devices)
- On browsers, there's actually a reduction elsewhere, from reducing time on sites (likely due to aggregator sites)

Discussion and implications

- When designing interventions, we should consider effects not just on the targeted behavior, but the workflow as a whole

Limitations

- Only monitoring time on phones and browsers
  - Cannot observe if time is being redistributed to non-digital activities
- Only studied productivity domain
  - “Absence of negative secondary effects” may not generalize to other behavior change domains

Conclusion

- Does reducing time via interventions influence time spent elsewhere?

Conclusion

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- Within-device: reduction on browser

Isolation

Redistribution

Reduction

Browser

Conclusion

- Does reducing time via interventions influence time spent elsewhere?
- Within-device: reduction on browser, but not mobile

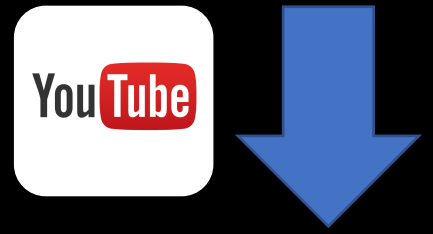
Isolation

Mobile

Redistribution

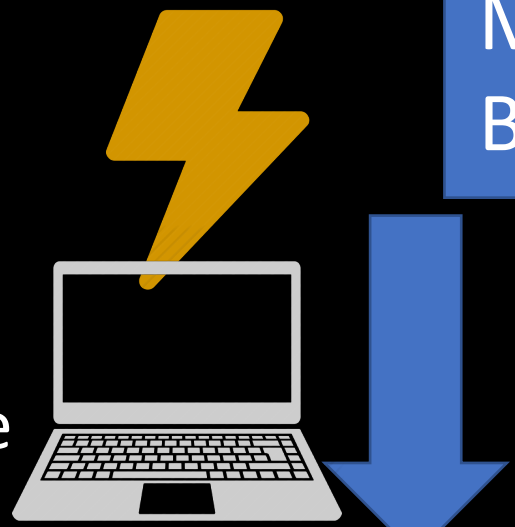
Reduction

Browser



Conclusion

- Does reducing time via interventions influence time spent elsewhere?
- Within-device: reduction on browser, but not mobile
- Cross-device: no effects



Isolation

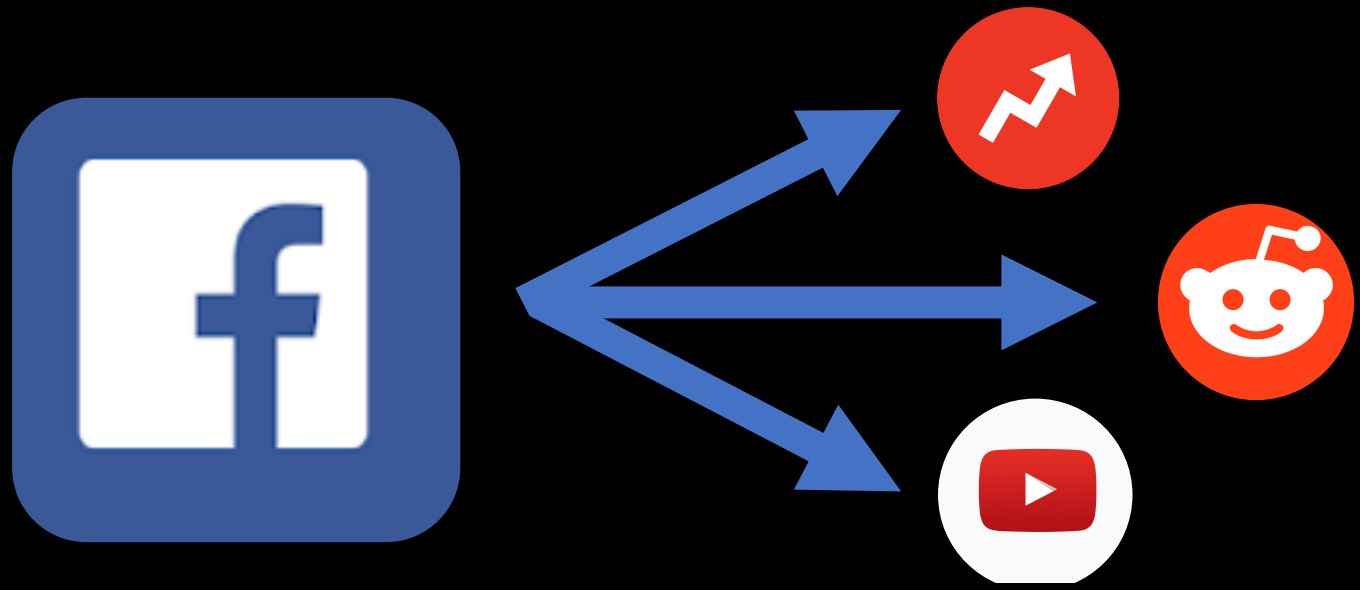
Mobile → Browser
Browser → Mobile

Redistribution

Reduction

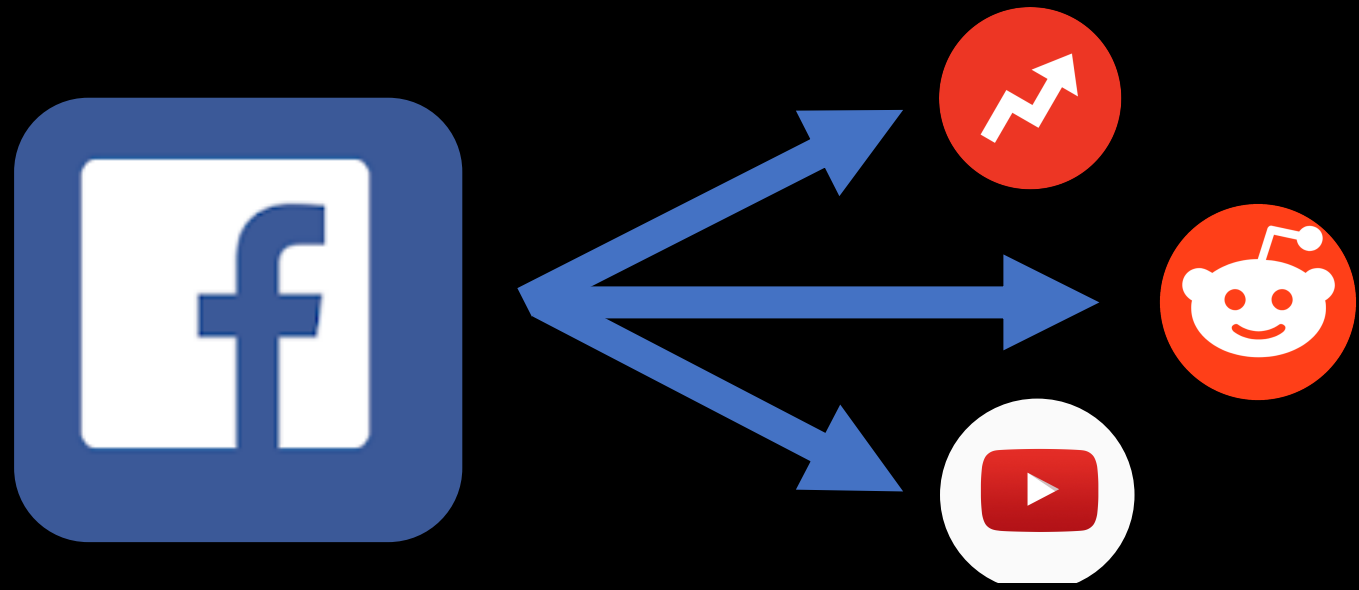
Conclusion

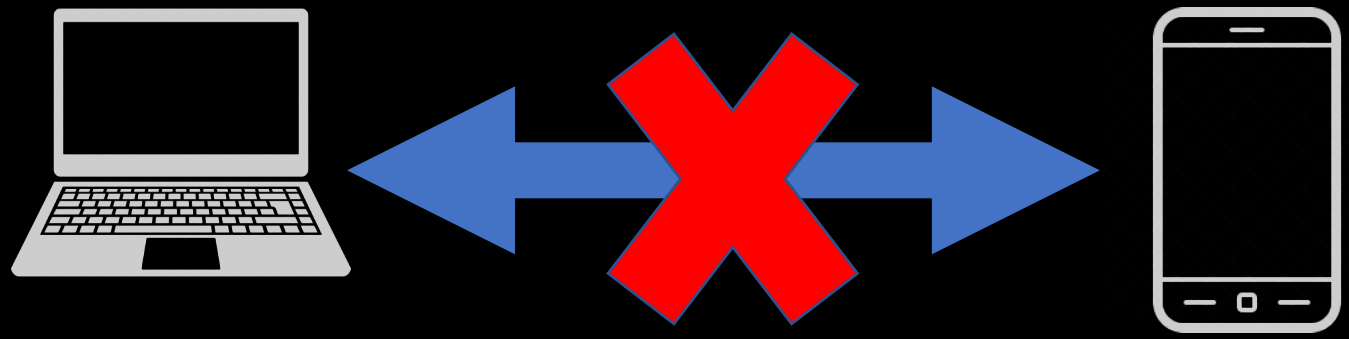
- Does reducing time via interventions influence time spent elsewhere?
- Within-device: reduction on browser, but not mobile
  - Due to aggregator sites driving traffic to other sites
- Cross-device: no effects



Conclusion

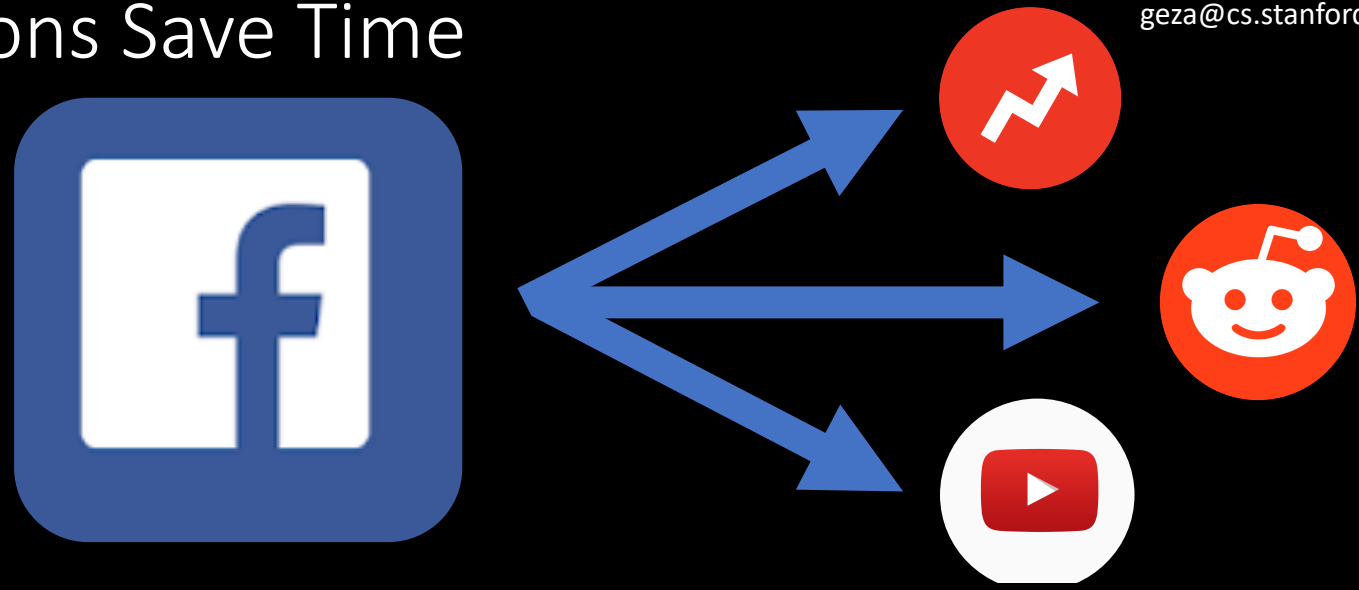
- Does reducing time via interventions influence time spent elsewhere?
- Within-device: reduction on browser, but not mobile
  - Due to aggregator sites driving traffic to other sites
- Cross-device: no effects
  - Devices used in different contexts





Conservation of Procrastination: Do Productivity Interventions Save Time or Just Redistribute It?

Geza Kovacs
geza@cs.stanford.edu



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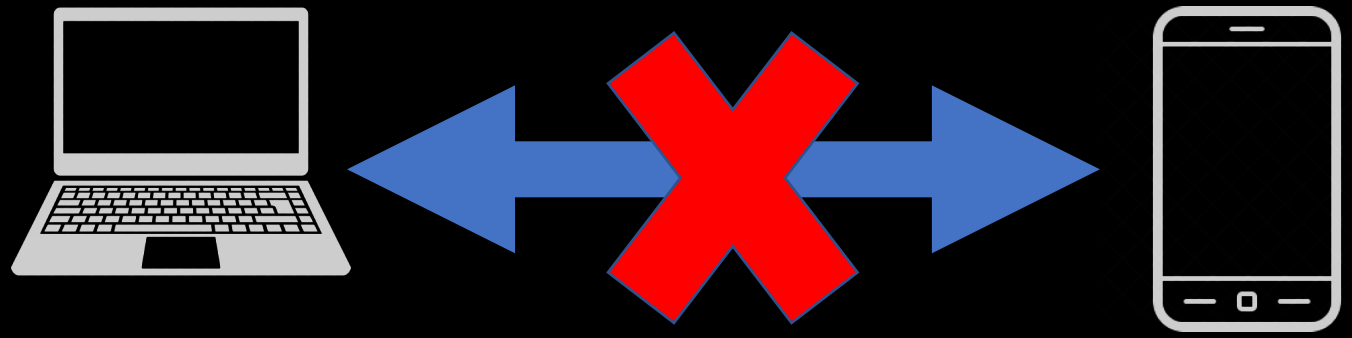
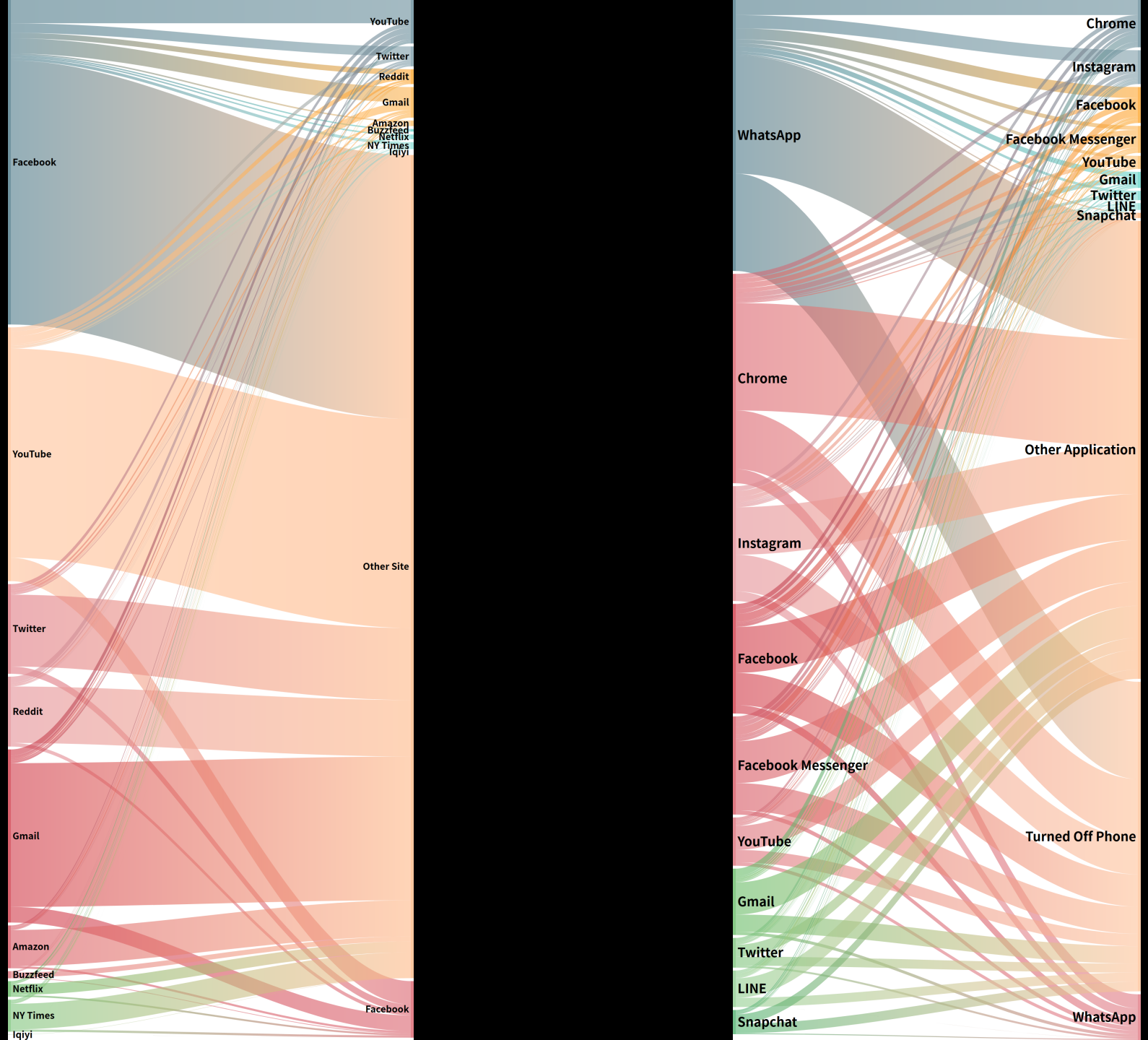


https://habitlab.github.io

Backup Slides


Facebook
YouTube
Twitter
Reddit
Gmail
Amazon
Buzzfeed
Netflix
NY Times
Iqiyi
YouTube
Twitter
Reddit
Gmail
Amazon
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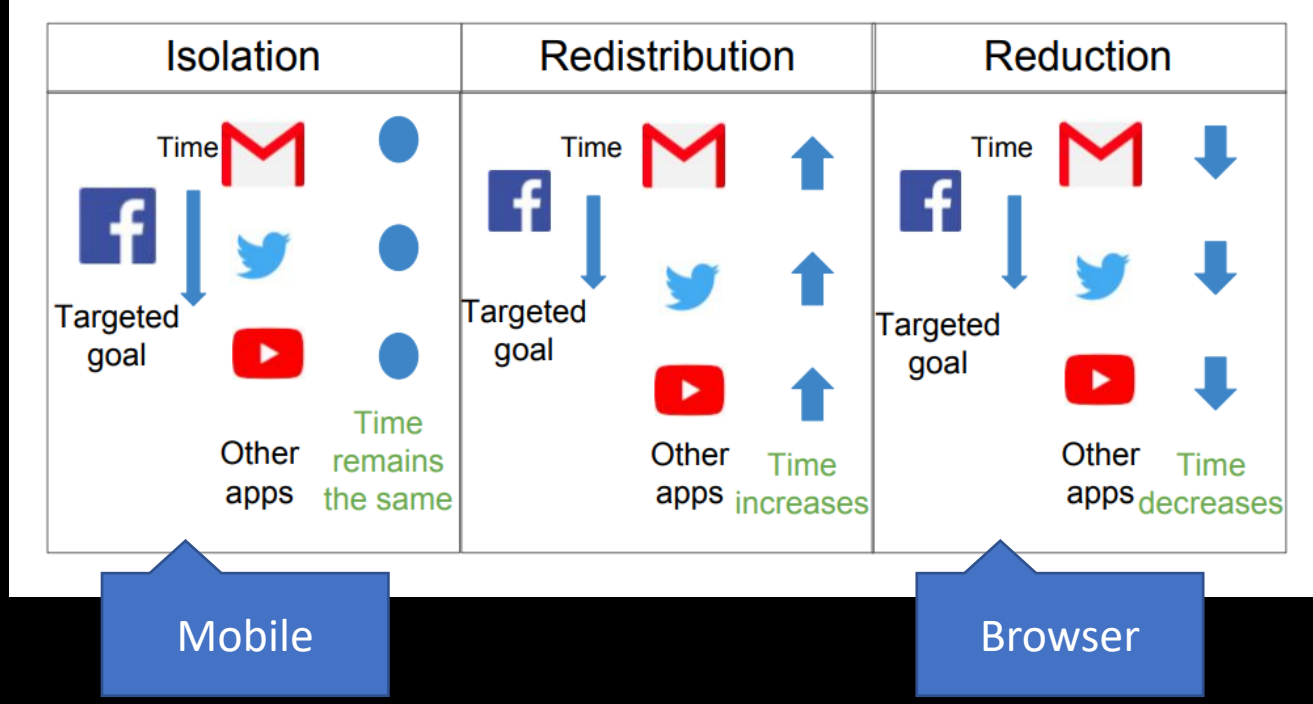
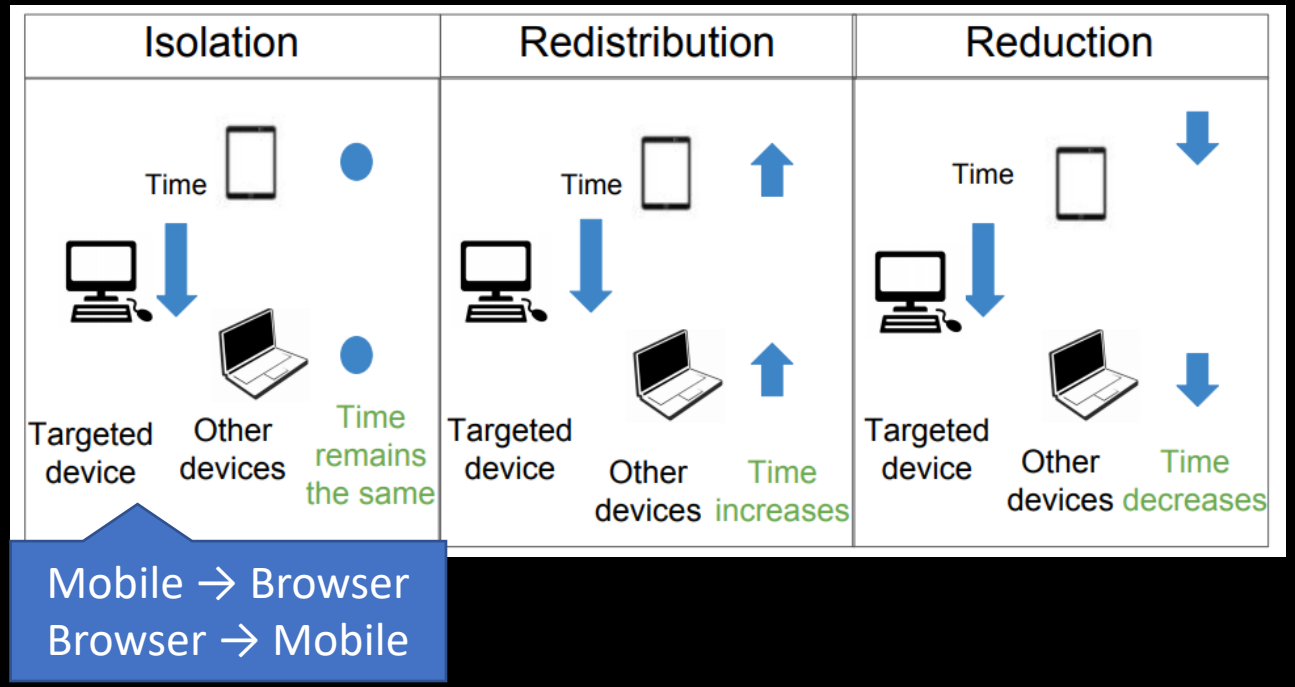
Netflix
NY Times
Iqiyi
Other Site
Facebook
WhatsApp
Chrome
Instagram
Facebook
Facebook Messenger
YouTube
Gmail
Twitter
LINE
Snapchat
Chrome
Instagram
Facebook
Facebook Messenger
YouTube
Gmail
Twitter
LINE
Snapchat
Other Application
Turned Off Phone
WhatsApp

1.	(not set)	**701**	(5.63%)
2.	New York	**202**	(1.62%)
3.	Bogota	**135**	(1.08%)
4.	Madrid	**132**	(1.06%)
5.	London	**126**	(1.01%)
6.	San Francisco	**124**	(1.00%)
7.	Moscow	**118**	(0.95%)
8.	Stanford	**110**	(0.88%)
9.	Los Angeles	**100**	(0.80%)
10.	Sydney	**98**	(0.79%)

Conclusion

- Does reducing time via interventions influence time spent elsewhere?
- Within-device, we observe reduction on browser, but not mobile
  - Perhaps due to goal sites driving traffic to other sites
- Cross-device, we observe no effects

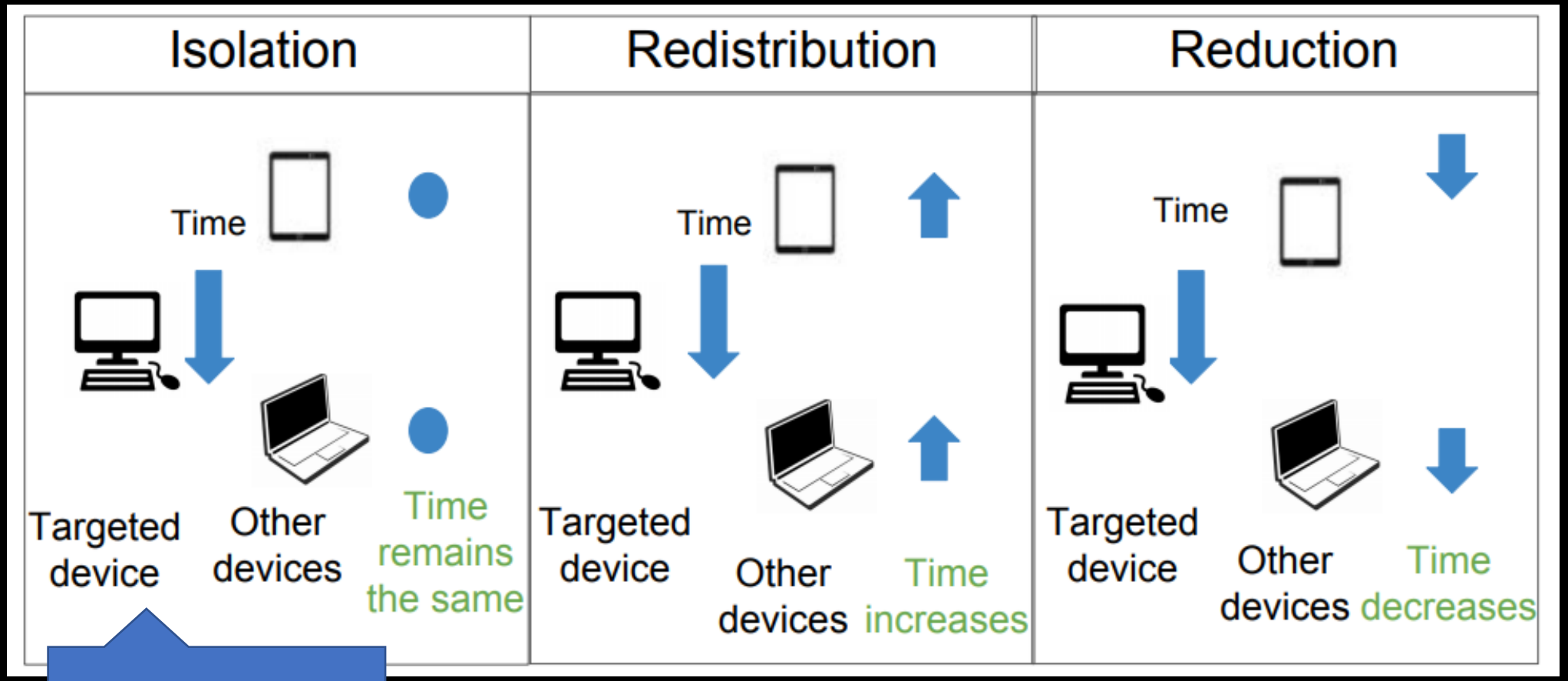




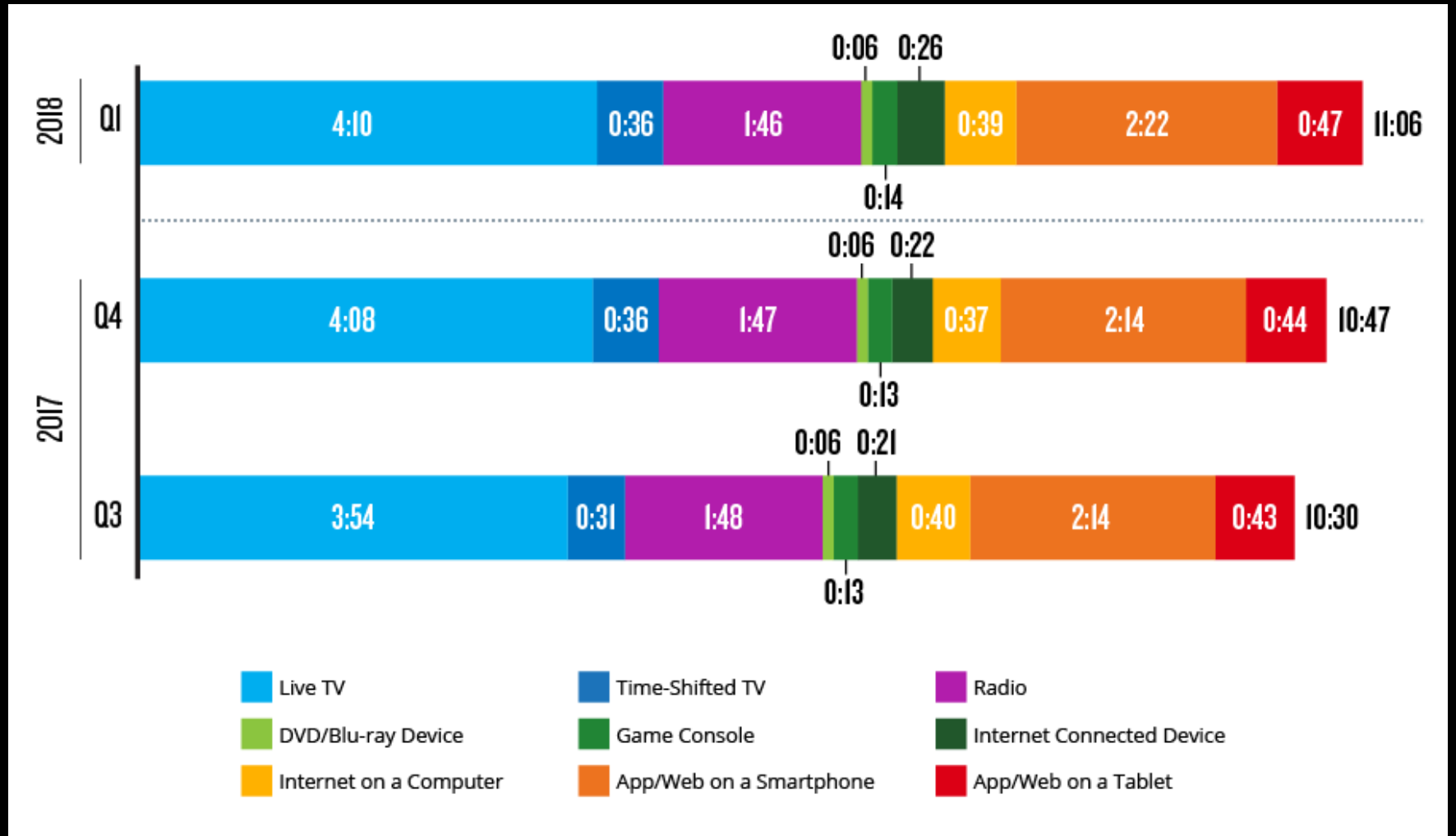
Conclusion

- Does reducing time via interventions influence time spent elsewhere? 3 possibilities:
  - No effect (isolation)
  - Increases time spent elsewhere (redistribution)
  - Decreases time spent elsewhere (reduction)
- Within-device, we observe reduction on browser, but not mobile
  - Perhaps due to goal sites driving traffic to other sites
- Cross-device, we observe no effects

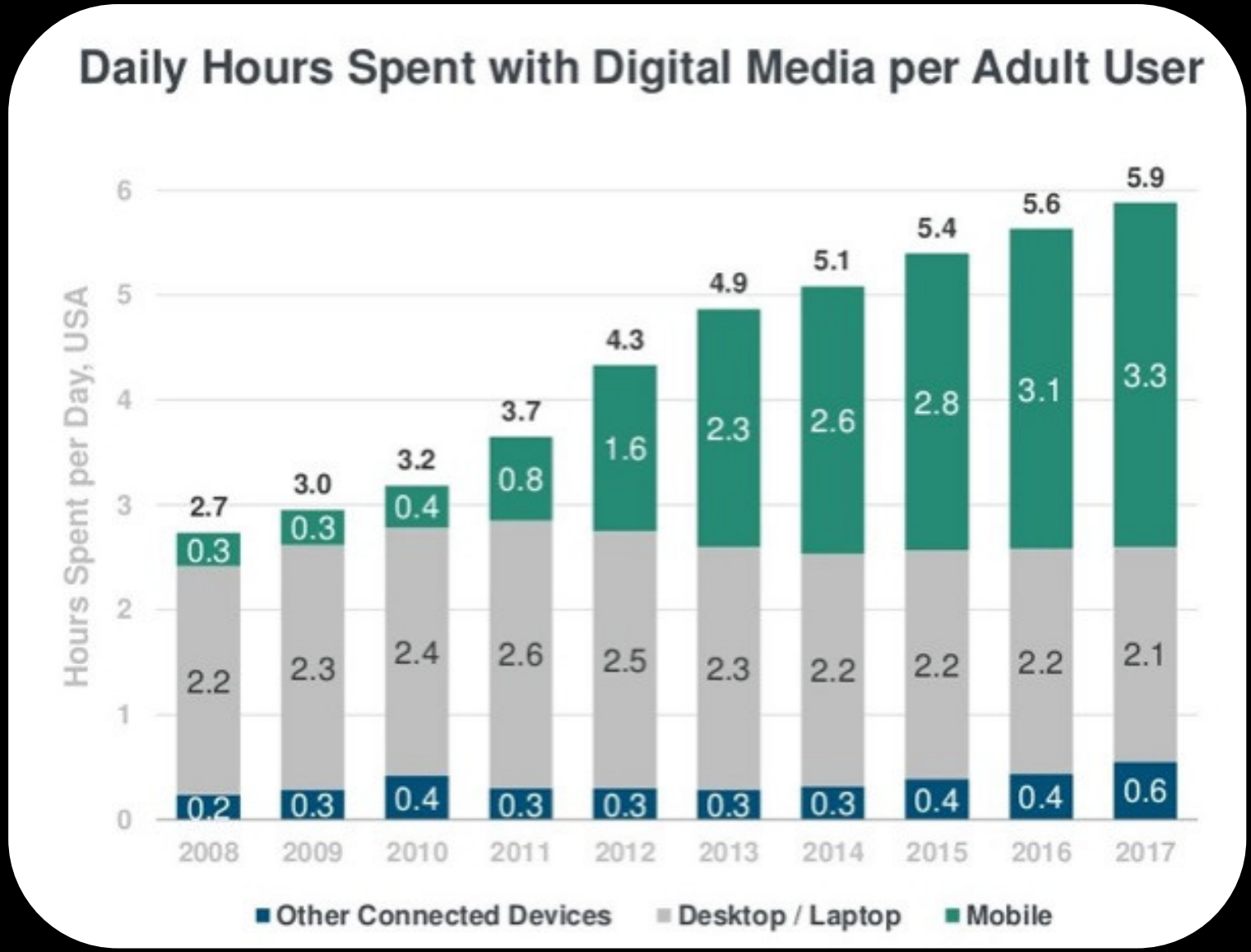
RQ2: Do interventions on one device influence time spent on the other device?



US adults spend **4.2 hours** each day browsing the web and using phone apps



Q1 2018 Nielsen Total Audience Report

People spend increasing amounts of time online

Average US adult spends 5.9 hours per day with digital media