Privacy Perceptions About Health and Non-Health Mobile Apps

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Abstract

This poster describes Phase 1 of a survey study to examine the relationship between U.S. consumers' expectations about how different types of apps will handle user data, and their assumptions about how laws and app store rules regulate handling of that data. We compare data practices of health apps with non-health apps. Statistical evaluation of responses from 307 participants found that their views about what laws or store rules say—or should say—about apps' likely data practices tended to correlate positively with characteristics of those data practices, including their health-relatedness and sensitivity, and may correlate with characteristics of the app. In the planned Phase 2 of the study, we will refine these work-in-progress results.

1 Introduction

The Apple App Store has 123K+ apps in its Health & Fitness and Medical categories combined, while the Google Play Store has 135K+ [3]. These apps encompass a wide range of functions, from monitoring glucose levels to providing lifestyle tips. [2]. Despite many benefits, the use of mobile health apps may lead to privacy violations [9, 11, 16, 17, 19, 21, 23], particularly if users are not informed [4, 10, 16, 18, 20] or do not understand [14, 15, 24–26] what the apps are doing.

The U.S. Health Insurance Portability and Accountability Act (HIPAA) establishes a clear baseline of privacy protection. However, HIPAA applies only to data that is generated in the context of medical care. Other apps with health-related purposes, such as fitness apps or period and pregnancy trackers, are not covered—but most consumers do not have a fine-grained knowledge about what specific privacy laws cover [5, 13, 22].

App stores are beginning to add transparency requirements about use of health data more broadly [1, 6, 7]. However, to ensure that such efforts are actually effective, more information is needed about how users reason about how different types of apps handle health data [5]. In particular, we believe it is necessary to examine perceptions of apps that might be considered "health apps", but are not subject to requirements for medical data handling.

We are conducting a series of studies to examine the potentially complex relationship between people's perceptions about how apps with different topics are likely to behave, and their perceptions about what laws and mobile app store rules or restrictions do and should apply to those apps and to how the apps handle data. At a high level, our research questions for this study are:

- How do(es) the perceived health- and/or medical-relatedness of an app's purpose and/or data practices affect:
  - People's views on what legal and app store provisions apply, or should apply, to that app or those data practices; and
  - Whether they think apps are likely to act within those restrictions?

Here we describe Phase 1 of our study, a survey with 307 people based on descriptions of apps in 6 categories that *a priori* seemed to vary widely in medical/health-relatedness and sensitivity. The results showed the people's perceptions about data handling and about legal and app store restrictions vary significantly across those very disparate topics.

Methods We used Prolific.co to recruit 307 participants in the U.S. Participants were split randomly between six conditions and shown one of six sample apps: telehealth, blood

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donation, step counting, kinky dating, STI diagnosis/help, or flashlight. We created fake app descriptions based on Play Store apps; see Appendix B. The survey asked participants to predict the apps' data practices. It then asked Likert-scale questions about whether the data practices were legal and allowed by app stores, and whether they are health-related, sensitive, or relevant; and about health-data protection laws and app store rules in general. Further details about methods may be found in Appendix A, and the survey instrument in C.

2 Findings from Phase 1

As expected, chi-square tests showed statistically significant variation ($p < .01$) between participants who saw different app prompts for nearly all questions about the specific apps, or the data practices participants had suggested for them. (And did not show statistically significant variation by app prompt for questions about whether laws and app stores protect health/medical data *in general*.) Participants' views on whether laws and store rules *should* allow data practices had more statistical variance than their expectations about whether store rules *do* allow data practices. In other words, most participants thought laws and store rules were fairly permissive, but some thought they shouldn't be. Descriptive statistics for each variable, including variance, are in Appendix D.

We conducted binary logistic regressions to help unpack which characteristics of the apps and data practices drove the variation. Tests of 1418 candidate 2-variable and 3-variable relationships showed that participants' assessment of the characteristics of the data practices they thought the app was likely to engage in (their health-relatedness, medical relevance, and sensitivity), and of those data practices' relevance to the app's purpose, tended to be *positively correlated* with those participants' expectations about whether those data practices are legal/allowed for those apps and (especially) with their views on whether those data practices *should* be legal/allowed for those apps. (Selected regression results can be found in Appendix E.) For the most part, participants' views about what laws or store rules *should* say were more strongly correlated with other variables than were their views about what laws or store rules *do* say.

Participants' expectations about whether it is legal/allowed for apps to collect the data types they had predicted, in turn, tended to correlate positively with characteristics of the app (the health-relatedness, medical relevance, and sensitivity of its purpose), but legality/allowability of recipients and data uses generally did not or were borderline. (This may have been an effect of study design; there was also less correlation between app purpose and characteristics of recipients and data uses, compared to data types.) We therefore do not yet have a clear picture of whether users' assessments of app purpose are likely to be *directly* correlated with their expectations and preferences about the legality/allowability of likely data practices.

Lastly, we found no R^2 correlation between predicted data practice characteristics and participants' views on whether, *in general*, laws and store rules protect (or should protect) health or medical data.

We found that judgments about health-relatedness and medical-relatedness were not identical, but were similarly predictive of other variables. This suggests rethinking whether having both medical and health variants of questions provide any utility for our study. Similarly, views about laws and store rules were tightly correlated with each other, and were somewhat similarly predictive.

Implications So Far Our preliminary results indicate that the context of an app, and how it presents itself, can affect perceptions about privacy protections. An app presenting itself as a health or medical app may therefore be granted more privacy leeway, whether or not it's merited. We also found that people may think legal and app store protections aren't as health-specific as they should be. Lastly, if the split between data type and other practices holds up in Phase 2, it may suggest a focus on making *data type collection* more transparent.

3 Planned Phase 2 Study Design

Having shown that our study design is useful for identifying distinctions between apps on our target dimensions, Phase 2 will expand the number of apps, and at the same time focus more closely on apps where it seems likely that users may find it harder to determine whether an app is likely subject to regulations about health data, and/or whether it is likely to treat data with extra care. Topics might include pulse/fitness tracking, period and pregnancy trackers, addiction support, or dating apps aimed at people with chronic STIs.

Phase 2 will consist of two surveys. In Survey 1, participants will rate a) app descriptions and b) data practices drawn from Phase 1 participants' guesses and existing datasets, on dimensions of health-relatedness, medical-relatedness, and sensitivity. In Survey 2, participants will read an app description and answer questions about likeliness and relevance-to-purpose of data practices, and whether they are allowed by app stores.

We will conduct rigorous hypothesis testing with only the most promising factors identified in Phase 1. For example, we will drop all questions about whether laws and store rules *in general* protect or should protect health/medical data. We also plan to focus on app store rules, as Phase 1 findings about laws vs. app store rules were not wildly different. We can thus better scope Phase 2 to providing recommendations to app stores about how they handle apps that collect health data or that have broadly health-related purposes.

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A Detailed Methods (Phase 1)

Sample App Creation To select the app topics, we began by examining how apps are presented in the Apple and Google app store; we then identified common topics from apps in the "Health & Fitness" and "Medical" categories via unsupervised machine learning and human-conducted corpus linguistics; and reviewing relevant literature. In the process, we identified a range of app topics that (we hypothesize) vary on dimensions of health-related-ness, medical relevancy, and (separately) sensitivity.

For the exploratory Phase 1, we selected six topics that met a threshold for number of apps with that topic, and cumulative number of downloads that we expected to cover the full space of medically-relevant vs. not, health-related vs. not, and sensitive vs. not: telehealth, blood donation, step counting, kinky dating, STI diagnosis/help, and flashlight.

Rather than using examples of real apps, we created fake apps, mimicking the style and content of descriptions of actual apps with those topics in the Google Play Store, but within a proscribed outline. This approach aimed to make sure we identified factors related to participants' general perceptions about these types of apps, beyond the specific app we might use as an example (where, for example, personal experience or visual aspects of the app store ad might confound the results), and allowed us to avoid mentioning specific data practices. (See Appendix B for the descriptions.)

As a basis for creating each sample app, we gathered a list of apps to examine from the Google Play Store. We began by using keywords to identify a representative app for the topic, then used a scraper to collect related apps, based on what is provided by the Play Store (what Google deems as similar to this app). We recursively collected neighboring apps until we reached a certain depth, in terms of steps away from the original, or until all similar apps had already been seen. We then checked the list and culled all apps that were not actually on-topic.

Survey Structure Using a between-subjects design, we randomly presented each participant with one of our six sample apps. We first asked participants about what types of data they think the app will collect, who it will share it with, and how the app will use the data.[1] (See Figure 1.)

We then asked participants whether they thought the data handling practices that they themselves had predicted were allowed by (1) laws and (2) mobile app platform rules, and whether they think they should be allowed. We next asked participants about whether they think the app's self-described purpose and the participants' predicted data handling practices are relevant to health or medicine, whether people are likely to find them sensitive, and whether they are likely to be relevant to the purpose of the app. Finally, as a point of comparison, we asked whether participants are aware of *general* laws and app store rules specific to health or medical data, and whether they think there should be such laws.

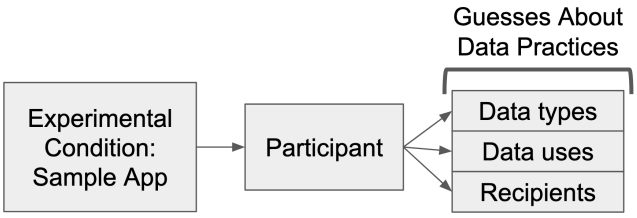

Figure 1: Assignment of conditions and generation of data practice predictions by participants.

Other than the initial free-answers about predicted data practices, the majority of the questions were answered on Likert scales (usually mirrored). We also asked questions about mobile app proficiency and demographics in an exit survey.

Deployment After receiving an IRB exemption determination from ICSI's Human Research Protections Committee, we piloted the survey and then used the Prolific.co platform to recruit 307 participants in the U.S. Participants were split randomly between the 6 conditions.

Hypothesis Construction and Statistical Evaluation In addition to descriptive statistics (average and variance) for each question/variable, we used a chi-square test [8] to compare the frequency distributions between answers to each question depending on which app the participant was shown. This test can tell us whether answers vary by app, but not what characteristics of that app caused the variation. This is why we also included explicit questions about those characteristics in the survey, to test their correlations with other variables.

In this first phase of the study, we used binary logistic regression [12] to evaluate R^2 correlations between variables. (Where each multiple-choice survey question represents a variable. Note that questions about characteristics of data practices, which were repeated up to three times per participant—as they could make up to three guesses per practice—had more values than the other variables. We also added a boolean variable for whether the participant had made any guesses at all for each data practice.)

We first assessed all combinations of 2 variables (630 possible combinations) and combinations of 3 variables (21,420

[1] We chose this structure to limit the data practices we explored to those that participants thought likely. However, since participants seemed to find it easier to come up with data types than recipients or uses (judging by how many came up with three guesses for each data practice), it may be that their guesses about recipients or uses more quickly reached the limits of obvious relevance, and participants may have begun making more random guesses.

possible). Figure 2 gives an overview of the types of 2-variable interactions. We discarded any hypotheses that were ill-constructed or that *a priori* did not have any reasonable support. (For example, there is no reason to hypothesize a correlation between someone's opinion on whether the purpose of a given app is sensitive and their general assumptions about whether laws that protect health data exist.) This left us with 307 2-place hypotheses and 1111 3-place hypotheses to test. This broad hypothesis testing allowed us to assess whether our initial hypotheses are likely to be correct, and to select the most promising factors to test rigorously in the second phased of the study.

For the regressions, we consolidated the scaled answers for each question to a simple binary value (dropping neutral middle values in 5-point scales). For example, for the answer scale *strongly agree, mostly agree, neither agree nor disagree, mostly disagree, strongly disagree*, we dropped *neither agree nor disagree* and collapsed the 'mostly' and 'strongly' answers to *agree* and *disagree*. (For sensitivity, we binarized between *not at all upset* and all other answers.)

B App Descriptions (Phase 1)

Participants were shown the app descriptions below. Each description begins with a sentence mentioning the purpose of the app, followed by a paragraph touting features that were common among examples we reviewed. However, we avoided mentioning specific data types, recipients, and (to the extent possible) data uses, as we planned to ask participants to make their own predictions.

We also include one version of the string that was inserted into instructions and specific questions about the purpose of the app.

STI Helper+

App that provides up-to-date information and treatment for common Sexually Transmitted Diseases (STDs) and infections. STI Helper+ includes causes, treatments, and diagnosis. Download this app to get detailed information about the most common STDs and infections. Users can get a customized treatment plan from specialists around the world. Help inform yourself and others of safe practices using STI Helper+.

App purpose (as used in questions): provide information and help for sexually transmitted infections

Simple Blood Donation

The easy-to-use "Simple Blood Donation" makes blood donation registrations and appointments hassle-free and completely digital. Furthermore, Simple Blood Donation allows you to track and manage your blood donations wherever you go. Now, you can save the lives of many people in just a couple swipes and taps! Giving blood to those in need has never been easier. Welcome to the digital era of blood donation!

App purpose (as used in questions): manage and track users' blood donations

Step Count Manager

Manage the number of steps you do daily with 'Step Count Manager'. Set daily goals and keep track of previous step counts to watch your progress. Step Count Manager includes a calorie calculator, speed calculator, and walk tracker. Step Count Manager is designed to push you to your limits and help you lose weight faster! This app will track your steps, whether your phone is active or in sleep mode. Start your healthy lifestyle NOW with 'Step Count Manager'.

App purpose (as used in questions): log and track users' daily step counts

Kink Finder Extra

Are you seeking a safe community of people who share your kink? Use Kink Finder Extra to join a community with millions of active users who discuss and seek kinky lifestyles. Join several communities to meet curious couples and singles, interested in BDSM, fetish, kink, and more. Whether you are looking for something serious or casual, Kink Finder Extra will connect you with local users who share your fetish or kinks.

App purpose (as used in questions): connect local users who share the same kinks and fetishes

Ideal Flashlight

Transform your phone into a flashlight with Ideal Flashlight! Ideal Flashlight is easy and simple to use and with a touch of a button, you can transform the rear view of your camera into a powerful flashlight. We also include some extra features, like customizing the lights to use different colors and enabling your flashlight to signal an SOS in morse code. Also, use your LED screen to make yourself your own colored lamp light. This is the brightest and best flashlight with several features, so don't snooze on Ideal Flashlight.

App purpose (as used in questions): transform the phone into a handy flashlight

Telehealth Pocket

Do you imagine speaking and getting connected instantly with a doctor to answer your pressing medical questions? Imagine being able to access important healthcare information on the go? It's all possible in "Telehealth Pocket", where you can consult with millions of doctors worldwide through voice and video chat. No long queues and far commutes – you can get medical help anywhere as long as you have the app installed. Our app provides hassle-free ways to book an appointment, get prescriptions, and do virtual consultations with your doctor

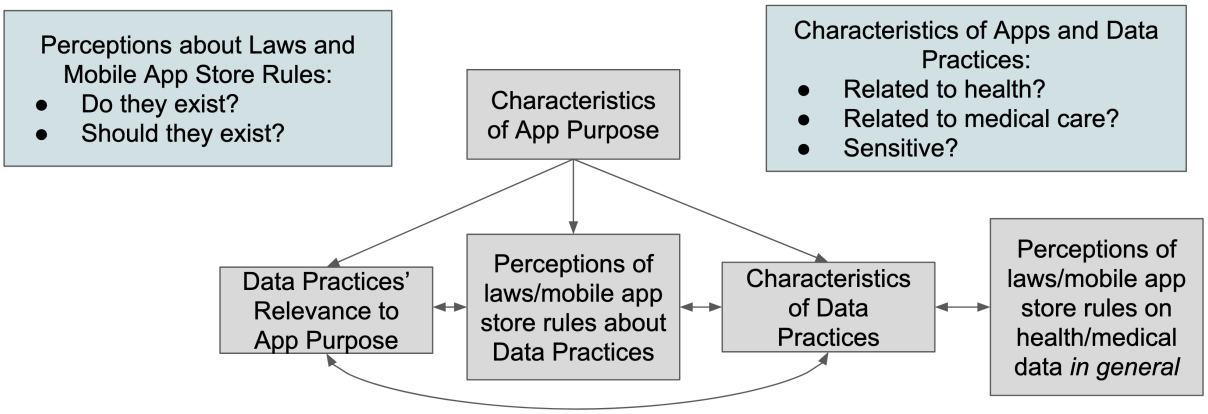

Figure 2: Hypothesized interactions between sets of variables.

in the comfort of your own pocket. Download our app today to move forward to the future of medical care.

App purpose (as used in questions): connect users with doctors for online consults

C Survey Instrument (Phase 1)

[App names, purposes, and descriptions varied between the six conditions. For the text of each, see Appendix B.]

Imagine you're a user of [APP NAME], a made-up app that you use to [APP PURPOSE]. Please read the app description below, and then answer the questions about what you think would happen with an app like this. It's okay if you're not sure about a topic; just make your best guess.

[APP NAME]

[APP DESCRIPTION]

Instructions: The first set of questions ask you to make some guesses about how [APP NAME] handles data. Please think about the kind of data you think [APP NAME] collects, who it sends data to, and what it uses data to do.

What kinds of data do you think [APP NAME] collects? Name up to three kinds of data that come to mind.

Data type 1 _____
Data type 2 _____
Data type 3 _____
___ Not applicable / I don't think it collects any data.

[Participants' answers to this question will be used in later questions. They are referred to below as [DATA TYPE.x].]

Who do you think [APP NAME] sends data that it collects to? Name up to three recipients that come to mind.

Recipient 1 _____
Recipient 2 _____
Recipient 3 _____
___ Not applicable / I don't think it sends data to anyone.

[Participants' answers to this question will be used in later questions. They are referred to below as [RECIPIENT.x].]

How do you think [APP NAME] uses data that it collects? Name up to three uses that come to mind. You can include all kinds of things that [APP] could use data for.

Data use 1 _____
Data use 2 _____
Data use 3 _____
___ Not applicable / I don't think it uses data for anything.

[Participants' answers to this question will be used in later questions. They are referred to below as [DATA USE.x].]

Instructions: When answering the following questions, please think about any laws and regulations *set by the government* to protect data, and how they may affect what [APP NAME] can do with your data. Remember it's okay if you're not sure; please make your best guess.

[Where all questions in a block have the same set of possible answers, the answers appear once at the end of the block, for purposes of this document. In the actual survey, each set of questions and scaled answers was displayed as a grid.]

Do *current laws* allow [APP NAME] to collect [DATA TYPE.x]? *[iterate for each value of DATA TYPE.x]*

[or for participants who chose 'I don't think it collects any data'] Do *current laws* allow [APP NAME] to collect data from users?[2]

Do *current laws* allow [APP NAME] to send its users' data to [RECIPIENT.x]? *[iterate for each value of RECIPIENT.x]*

[2]Answers to these dummy questions were not used; participants who did not make any guesses about data types were dropped from analysis of this variable. (Similarly for recipients and data uses.)

[or for participants who chose 'I don't think it sends data to anyone'] Do *current laws* allow [APP NAME] to send its users' data to other parties?

Do *current laws* allow [APP NAME] to use its users' data for [DATA USE.x]? *[iterate for each value of DATA USE.x]*

[or for participants who chose 'I don't think it uses data for anything'] Do *current laws* allow [APP NAME] to use its users' data for anything?

[Answer options for the block of questions above:]
Definitely yes
Likely yes
I don't know
Likely no
Definitely no

Instructions: The next set of questions are only about mobile platforms like the Google Play Store (Android) or the Apple App Store (iOS), and their rules about what apps like [APP NAME] are allowed to do with your data. Please consider *only* the rules of the mobile platforms and their app stores, not laws or regulations set by the government, nor the privacy policies of individual apps.

Do *current mobile app store rules* allow [APP NAME] to collect [DATA TYPE.x]? *[iterate for each value of DATA TYPE.x]*

[or for participants who chose 'I don't think it collects any data'] Do *current mobile app store rules* allow [APP NAME] to collect data from users?

Do *current mobile app store rules* allow [APP NAME] to send its users' data to [RECIPIENT.x]? *[iterate for each value of RECIPIENT.x]*

[or for participants who chose 'I don't think it sends data to anyone'] Do *current mobile app store rules* allow [APP NAME] to send its users' data to other parties?

Do *current mobile app store rules* allow [APP NAME] to use its users' data for [DATA USE.x]? *[iterate for each value of DATA USE.x]*

[or for participants who chose 'I don't think it uses data for anything'] Do *current mobile app store rules* allow [APP NAME] to use its users' data for anything?

[Answer options for the block of questions above:]
Definitely yes
Likely yes
I don't know
Likely no
Definitely no

Instructions: Please indicate how much you agree or disagree with the following statements about laws and regulations set by governments.

Laws should allow [APP NAME] to collect [DATA TYPE.x]. *[iterate for each value of DATA TYPE.x]*

[or for participants who chose 'I don't think it collects any data'] Laws should allow [APP NAME] to collect data from users.

Laws should allow [APP NAME] to send its users' data to [RECIPIENT.x] *[iterate for each value of RECIPIENT.x]*.

[or for participants who chose 'I don't think it sends data to anyone'] Laws should allow [APP NAME] to send its users' data to other parties.

Laws should allow [APP NAME] to use its users' data for [DATA USE.x]. *[iterate for each value of DATA USE.x]*

[or for participants who chose 'I don't think it uses data for anything'] Laws should allow [APP NAME] to use its users' data for things.

[Answer options for the block of questions above:]
Strongly agree
Mostly agree
Neither agree nor disagree
Mostly disagree
Strongly disagree

Instructions: Please indicate how much you agree or disagree with the following statements about rules set by mobile platforms/app stores.

Mobile app store rules should allow [APP NAME] to collect [DATA TYPE.x]. *[iterate for each value of DATA TYPE.x]*

[or for participants who chose 'I don't think it collects any data'] Mobile app store rules should allow [APP NAME] to collect data from users.

Mobile app store rules should allow [APP NAME] to send its users' data to [RECIPIENT.x] *[iterate for each value of RECIPIENT.x]*.

[or for participants who chose 'I don't think it sends data to anyone'] Mobile app store rules should allow [APP NAME] to send its users' data to other parties.

Mobile app store rules should allow [APP NAME] to use its users' data for [DATA USE.x]. *[iterate for each value of DATA USE.x]*

[or for participants who chose 'I don't think it uses data for anything'] Mobile app store rules should allow [APP NAME] to use its users' data for things.

[Answer options for the block of questions above:]
Strongly agree
Mostly agree
Neither agree nor disagree
Mostly disagree
Strongly disagree

Instructions: Please answer the following questions. If you're not sure, make your best guess.

How likely is it that collecting users' [DATA TYPE.x] will help [APP NAME] to [APP PURPOSE]? *[iterate for each value of DATA TYPE.x]*

[or for participants who chose 'I don't think it collects any data'] How likely is it that collecting data from users would help [APP NAME] to [APP PURPOSE]?

How likely is it that sending its users' data to [RECIPIENT.x] will help [APP NAME] to [APP PURPOSE]? *[iterate for each value of RECIPIENT.x]*

[or for participants who chose 'I don't think it sends data to anyone'] How likely is it that sending its users' data to other parties would help [APP NAME] to [APP PURPOSE]?

How likely is it that using its users' data for [DATA USE.x] will help [APP NAME] to [APP PURPOSE]? *[iterate for each value of DATA USE.x]*

[or for participants who chose 'I don't think it uses data for anything'] How likely is it that using its users' data would help [APP NAME] to [APP PURPOSE]?

[Answer options for the block of questions above:]
Very likely
Somewhat likely
Somewhat unlikely
Very unlikely

Instructions: Please indicate how likely or unlikely you think the following scenarios are.

[The following questions were skipped if a participant did not make any guesses about that data practice at the beginning of the survey.]

Knowing someone's [DATA TYPE.x] could be relevant to understanding their health. *[iterate for each value of DATA TYPE.x]*

[RECIPIENT.x] could use someone's data to help them with their health. *[iterate for each value of RECIPIENT.x]*

Using someone's data for [DATA USE.x] could help them with their health. *[iterate for each value of DATA USE.x]*

Someone's [DATA TYPE.x] could be used to provide them with medical care. *[iterate for each value of DATA TYPE.x]*

[RECIPIENT.x] could use someone's data to provide them with medical care. *[iterate for each value of RECIPIENT.x]*

Someone's data could be used for [DATA USE.x] to provide them with medical care. *[iterate for each value of DATA USE.x]*

Using an app to [APP PURPOSE] could help someone with their health.

Someone could use an app to [APP PURPOSE] as part of their medical care.

[Answer options for the block of questions above:]
Very likely
Somewhat likely
Somewhat unlikely
Very unlikely

Instructions: Please answer the following questions about how you think people generally feel in certain situations.

[The following question was skipped if a participant did not make any guesses about data types at the beginning of the survey.]

How upset would most people be if their [DATA TYPE.x] became public knowledge? *[iterate for each value of DATA TYPE.x]*

How upset would most people be if it became public knowledge that they'd used an app to [APP PURPOSE]?

[Answer options for the block of questions above:]
Very upset
Fairly upset
A little upset
Not at all upset

Instructions: When answering the following questions, please consider any relevant laws and government regulations that may affect what mobile apps *in general* can do with your *health* data and information; we'll also ask about *medical* data and information. In these questions, we're focusing on what laws say specifically about *health* data or *medical* data. Remember it's okay if you're not sure; please make your best guess.

Note: *Health* pertains to one's well being (mental or physical condition) while *medical* pertains to someone's healthcare (a service that maintains and/or restores one's health).

Are there currently any *laws* that cover what mobile apps can and can't do specifically with *health-related data*?

Are there currently any *laws* that cover what mobile apps can and can't do specifically with *medical data*?

[Answer options for the block of questions above:]
Definitely yes
Likely yes
I don't know
Likely no
Definitely no

Instructions: For the next set of questions, please consider mobile platforms such as the Google Play Store (Android) or the Apple App Store (iOS), and their rules about what apps on those platforms can do specifically with your health or medical data and information.

Do *mobile app stores* currently have any rules that say what apps can and can't do specifically with *health-related data*?

Do *mobile app stores* currently have any rules that say what apps can and can't do specifically with *medical data*?

[Answer options for the block of questions above:]
Definitely yes
Likely yes
I don't know
Likely no
Definitely no

Instructions: Please indicate how much you agree or disagree with the following statements about laws and regulations set by governments.

There should be *laws* that say what apps can and can't do specifically with *health-related* data.

There should be *laws* that say what apps can and can't do specifically with *medical data*.

[Answer options for the block of questions above:]
Strongly agree
Mostly agree
Neither agree nor disagree
Mostly disagree
Strongly disagree

Instructions: Please indicate how much you agree or disagree with the following statements about rules set by mobile platforms/app stores.

There should be *mobile app store rules* that say what apps can and can't do specifically with *health-related data*.

There should be *mobile app store rules* that say what apps can and can't do specifically with medical data.

[Answer options for the block of questions above:]
Strongly agree
Mostly agree
Neither agree nor disagree
Mostly disagree
Strongly disagree

[The survey was followed by an exit questionnaire about ease of completing tasks on a mobile device, experience with technology, and demographics. The main part of the survey also included attention checks.]

D Descriptive Findings (Phase 1)

Table 1 provides detailed descriptive statistics of answers to each survey question.

Question	mean	median	std	var	scale
Characteristics of App Purpose:					
Using an app to [APP PURPOSE] could help someone with their health.	2.96	3	1.02	1.03	1-4
Someone could use an app to [APP PURPOSE] as part of their medical care.	2.91	3	1.05	1.11	1-4
How upset would most people be if it became public knowledge that they'd used an app to [APP PURPOSE]?	2.26	2	1.21	1.46	1-4
Characteristics of Predicted Data Practices:					
Knowing someone's [DATA TYPE.x] could be relevant to understanding their health.	2.79	3	1.10	1.21	1-4
Someone's [DATA TYPE.x] could be used to provide them with medical care.	2.89	3	1.05	1.10	1-4
How likely is it that collecting users' [DATA TYPE.x] will help [APP NAME] to [APP PURPOSE]?	3.03	3	1.04	1.09	1-4
How upset would most people be if their [DATA TYPE.x] became public knowledge?	2.90	3	1.07	1.14	1-4
Using someone's data for [DATA USE.x] could help them with their health.	2.41	2	1.15	1.33	1-4
Someone's data could be used for [DATA USE.x] to provide them with medical care.	2.29	2	1.12	1.26	1-4
Relevance of Predicted Data Practices to App Purpose:					
How likely is it that using its users' data for [DATA USE.x] will help [APP NAME] to [APP PURPOSE]?	2.71	3	1.19	1.42	1-4
[RECIPIENT.x] could use someone's data to help them with their health.	2.59	3	1.13	1.27	1-4
[RECIPIENT.x] could use someone's data to provide them with medical care.	2.40	2	1.14	1.30	1-4
How likely is it that sending its users' data to [RECIPIENT.x] will help [APP NAME] to [APP PURPOSE]?	2.51	3	1.17	1.37	1-4
Legality and Allowability of Predicted Data Practices:					
Do current laws allow [APP NAME] to collect [DATA TYPE.x]?	3.40	3	0.60	0.36	1-4*
Do current laws allow [APP NAME] to use its users' data for [DATA USE.x]?	3.42	3	0.59	0.35	1-4*
Do current laws allow [APP NAME] to send its users' data to [RECIPIENT.x]?	3.32	3	0.58	0.34	1-4*
Do current mobile app store rules allow [APP NAME] to collect [DATA TYPE.x]?	3.36	3	0.62	0.38	1-4*
Do current mobile app store rules allow [APP NAME] to use its users' data for [DATA USE.x]?	3.34	3	0.64	0.41	1-4*
Do current mobile app store rules allow [APP NAME] to send its users' data to [RECIPIENT.x]?	3.22	3	0.69	0.47	1-4*
Laws should allow [APP NAME] to collect [DATA TYPE.x].	3.62	4	1.17	1.37	1-5
Laws should allow [APP NAME] to use its users' data for [DATA USE.x].	3.50	4	1.33	1.77	1-5
Laws should allow [APP NAME] to send its users' data to [RECIPIENT.x]	3.14	3	1.37	1.89	1-5
Mobile app store rules should allow [APP NAME] to collect [DATA TYPE.x].	3.55	4	1.20	1.43	1-5

Continued on next page

Table 1 – continued from previous page

Question	mean	median	std	var	scale
Mobile app store rules should allow [APP NAME] to use its users' data for [DATA USE.x].	3.45	4	1.31	1.71	1-5
Mobile app store rules should allow [APP NAME] to send its users' data to [RECIPIENT.x]	3.05	3	1.39	1.92	1-5
Views About Laws and App Store Rules in General:					
Do mobile app stores currently have any rules that say what apps can and can't do specifically with health-related data?	2.95	3	0.63	0.39	1-4*
Do mobile app stores currently have any rules that say what apps can and can't do specifically with medical data?	3.12	3	0.65	0.42	1-4*
Are there currently any laws that cover what mobile apps can and can't do specifically with health-related data?	3.09	3	0.66	0.43	1-4*
Are there currently any laws that cover what mobile apps can and can't do specifically with medical data?	3.26	3	0.64	0.41	1-4*
There should be laws that say what apps can and can't do specifically with health-related data.	4.60	5	0.66	0.44	1-5
There should be laws that say what apps can and can't do specifically with medical data.	4.69	5	0.65	0.42	1-5
There should be mobile app store rules that say what apps can and can't do specifically with health-related data.	4.56	5	0.69	0.48	1-5
There should be mobile app store rules that say what apps can and can't do specifically with medical data.	4.66	5	0.63	0.40	1-5

Table 1: Descriptive statistics for each question/variable in Phase 1: mean, median, standard deviation, and variance. The 'scale' column gives the number of Likert options; * indicates an original 5-point scale where responses of *I don't know* have been dropped from the statistics. (So *Definitely yes* = 4; *Strongly agree* = 5; *Very likely* = 4; *Very upset* = 4.)

As Table 1 shows, people's views about whether laws and store rules *should* allow the data practices they predicted show more variance than their views on whether laws and store rules *do* allow them. Figure 3 illustrates the point in detail for store rules.

	Strongly disagree	Mostly disagree	Neither agree nor disagree	Mostly agree	Strongly agree
Should store rules allow collection of **data type**?	8%	12%	18%	42%	21%
Should store rules allow sharing with **recipient**?	17%	18%	21%	26%	18%
Should store rules allow this **data use**?	12%	14%	16%	35%	23%
Do store rules allow collection of **data type**?	0%	5%	15%	42%	37%
Do store rules allow sharing with **recipient**?	1%	6%	27%	39%	27%
Do store rules allow this **data use**?	1%	4%	17%	42%	36%
	Definitely no	Likely no	I don't know	Likely yes	Definitely yes

Figure 3: Answer frequencies for questions about regulation of data practices.

In all, 96% of participants made at least one prediction about data types collected, 93% made at least one prediction about data uses, and 84% made at least one prediction about recipients data could be shared with.

E Selected Regression Results (Phase 1)

Correlation of Characteristics with Specific Protection Expectations As Figure 4 shows, binary regression analysis found that participants' views about what laws or store rules say about data practices they predicted were correlated with the characteristics of the data practices (i.e. whether the data practice is health-related, medically relevant, sensitive, and/or relevant to the app purpose). Views about what laws or store rules *should* say were even more strongly correlated.

Participants' views about what laws or store rules say or should say about predicted data practices *may* have been directly correlated with characteristics of the app. (But it's less clear than the correlation with characteristics of the data practices.) Correlations especially seem weaker for recipients and data uses than for data types; however, this may be an effect of study design (to be corrected in Phase 2).

Correlation of Relevance with App Purpose Figure 5 shows a correlation between whether participants think the data types they predicted are relevant to the app purpose and whether they think that the app purpose is health-related, medical-related, and sensitive. The same correlations are not shown for relevance of predicted recipients and data uses (again, possibly an effect of study design).

Correlation of Characteristics with General Expectations About Protections Figure 4 shows that participants' expectations about whether there are, *in general*, laws and app store rules protecting health or medical data did not tend to correlate with whether they predicted apps would engage in health or medical-related data practices.

Correlations Between Characteristics As Table ?? shows, the health and medical rating of data practices that were provided by the users are highly correlated. The health and medical rating of an app is also correlated highly, though not as much as the data practices. This suggests that having a distinction between medical-relatedness and health-relatedness may not have much utility for our research question; we will reexamine this question after Study 1 in Phase 2.

Correlations Between Laws and App Store Rules Similar to health and medical variants, Table ?? shows that views on store rules and laws are highly correlated (with an exception to laws/rules protecting recipients), especially for *should* laws/store rules. In this case, we plan to focus on store rules in Phase 2.

Additional Regression Results A complete table of regression results checking correlations between all sensical pairs of two variables may be found at https://drive.google.com/file/d/1GFsdpr1W0ZyRKDrr5AIA6HEyvuwEk3fc/view?usp=sharing.

Relationship	R^2
Data Type: Health & Medical	0.92
Data Type: Health & Sensitive	0.89
Data Type: Medical & Sensitive	0.90
Recipient: Health & Medical	0.93
Data Usage: Health & Medical	0.94
App Purpose: Health & Medical	0.97
App Purpose: Health & Sensitivity	0.87
App Purpose: Medical & Sensitivity	0.85

Table 2: Correlations between questions about whether something is health-related, whether it's medically-relevant, and whether it's sensitive, keeping other components the same.

Relationship	R^2
Data Type: Do Laws & Do Store Rules	0.84
Data Use: Do Laws & Do Store Rules	0.87
Recipient: Do Laws & Do Store Rules	0.76
Data Type: Should Laws & Should Store Rules	0.98
Data Use: Should Laws & Should Store Rules	0.99
Recipient: Should Laws & Should Store Rules	0.98

Table 3: Correlations between questions about laws and questions about app store rules, keeping other components the same.

Regressions on Three-Place Hypotheses As it turned out, regressions on three-place hypotheses were largely unfruitful. Interactions between hypotheses did not tend to strengthen correlations beyond the R^2 values of the individual two-place hypotheses—and where they did, it did not tend to make enough of a difference to change whether a correlation could be shown. In other words, if we take $R^2 \geq 0.7$ as a cutoff for showing correlation, there were very few cases where two two-place hypotheses with an R^2 below 0.7 combined to make a three-place hypothesis with an R^2 above 0.7.

The few exceptions to this were cases where characteristics of the app purpose were significantly more influential when combined. For example, neither sensitive app purposes nor medically-relevant app purposes showed much correlation with whether participants thought those apps' likely data uses were allowed by app store rules ($R^2 = 0.55$ and 0.54, respectively), but app purposes that were both sensitive and medical did show a (weak) correlation with belief that likely data uses are allowed by store rules ($R^2 = 0.76$).

	App purpose health-related?	App purpose medical?	App purpose sensitive?	**Data type** health-related?	**Data type** medical?	**Data type** sensitive?	**Data type** relevant to purpose?
Do laws allow this collection?	**0.73**	**0.70**	**0.72**	**0.80**	**0.84**	**0.81**	**0.83**
Do store rules allow this collection?	0.69	0.67	0.69	**0.77**	**0.81**	**0.78**	**0.78**
Should laws allow this collection?	**0.78**	**0.76**	**0.76**	**0.89**	**0.90**	**0.89**	**0.94**
Should store rules allow this collection?	**0.78**	**0.76**	**0.76**	**0.89**	**0.89**	**0.89**	**0.94**

	App purpose health-related?	App purpose medical?	App purpose sensitive?	**Recipient** health-related?	**Recipient** medical?	**Recipient** relevant to purpose?
Do laws allow this sharing?	0.50	0.49	0.48	**0.75**	**0.75**	**0.75**
Do store rules allow this sharing?	0.44	0.44	0.41	0.67	0.67	0.67
Should laws allow this sharing?	0.53	0.52	0.49	**0.91**	**0.89**	**0.92**
Should store rules allow this sharing?	0.52	0.52	0.47	**0.91**	**0.90**	**0.92**

	App purpose health-related?	App purpose medical?	App purpose sensitive?	**Data use** health-related?	**Data use** medical?	**Data use** relevant to purpose?
Do laws allow this use?	0.57	0.56	0.58	**0.79**	**0.79**	**0.82**
Do store rules allow this use?	0.55	0.54	0.55	**0.75**	**0.75**	**0.77**
Should laws allow this use?	0.60	0.58	0.58	**0.91**	**0.90**	**0.95**
Should store rules allow this use?	0.60	0.58	0.57	**0.90**	**0.90**	**0.94**

Figure 4: Correlations of views on legality/allowability of predicted data practices with characteristics of app purpose and data practices. Cells show coefficient of determination (R^2).

	App purpose health-related?	App purpose medical?	App purpose sensitive?
Data type relevant to purpose?	**0.80**	**0.79**	**0.79**
Recipient relevant to purpose?	0.57	0.56	0.53
Data use relevant to purpose?	0.62	0.61	0.60

Figure 5: Correlations of relevance of predicted data practices to app purpose with characteristics of app purpose (R^2).

	Do laws generally protect medical data?	Do laws generally protect health data?	Do store rules generally protect medical data?	Do store rules generally protect health data?
Is predicted **data type** health-related?	0.66	0.57	0.60	0.56
Is predicted **data type** medical?	0.67	0.59	0.61	0.58
Is predicted **recipient** health-related?	0.46	0.40	0.43	0.42
Is predicted **recipient** medical?	0.45	0.39	0.42	0.42
Is predicted **data use** health-related?	0.51	0.44	0.49	0.46
Is predicted **data use** medical?	0.52	0.45	0.49	0.47

Figure 6: Correlations of characteristics of data practices with general views about laws and store rules (R^2).