

SARA: Data Curation Documentation

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This document provides details of decisions regarding the curation of SARA MRT data for Aims 1, 2, and 4. Other relevant material are provided at <https://github.com/jamieyap/SARA>

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1 Summary of Aims and Outcomes

Aim 1 (Primary): 4pm Notification

Primary proximal outcome: whether the survey and/or active tasks were fully completed in the evening of the same day (binary).

Independent variable: push notification with an inspirational message vs. no push notification with an inspirational message (binary).

Control Covariates:

1. whether the survey and/or active tasks were fully completed in the prior day (binary)
2. whether staff text or phone calls were made [to participants] in the last 24 hours [prior to time T where T = 4PM of the current day] (binary)
3. app usage outside of survey/task completion: whether the app was opened in the prior 72 hours [prior to time T where T = 4PM of the current day] outside of when survey and/or active task were completed (binary)¹

Aim 2 (Primary): After-Survey-Completion Reinforcement

Primary proximal outcome: whether the survey and/or active tasks were fully completed on the following day (binary).

Independent variable: offering a meme vs. not offering a meme after survey completion (binary)

Control Covariates:

1. whether the survey and/or active tasks were fully completed the prior day (binary)
2. whether staff text or phone calls were made [to participants] in the last 30 hours [prior to time T where T = time of randomization, time of survey completion, or 6PM of current day] (binary)²
3. app usage outside of survey/task completion: whether the app was opened in the prior 80 hours [prior to time T where T = time of randomization, time of survey completion, or 6PM of current day] outside of when survey and/or active tasks were completed (binary)³

¹72 hours to the app usage control covariate was heuristically chosen. A shorter length of time (e.g. 24 hours) was not chosen because it could give a spurious representation of engagement outside of survey/active task completion. A longer length of time (e.g. 10 days) is not useful because engagement may drop significantly within such long time periods. In contrast, 24 hours (and not more) was chosen in constructing the contact by study staff control covariate as the influence of human contact on engagement with app outside of survey/active task completion is less noisy than app usage. In addition, 24 hours was chosen in constructing the contact by study staff control covariate as the gap between any text or phone contact made by study staff to participants is at least 3 days.

²The reason is similar as for the 24 hour duration in Aim 1. Memes/GIFs were given to participants after completing their daily survey which is open for participants to complete between 6PM and midnight. 30 hours (and not 24 hours) was chosen to be able to cover any contact made by study staff to participants which were made between 6PM to midnight.

³80 hours is used for similar reasons as the 72 hours for 4PM notification. However, the extra 8 hours in the 80 hours is for the following reason: participants can fill out the daily survey anytime between 6PM to midnight. Now, if we count 72 hours instead of 80 hours from the daily survey completion, then we may or may not include interactions when participants completed daily surveys 3 days ago or interactions between 4PM to midnight, which we would like to cover when constructing this variable.

Aim 4 (Secondary): After-Active-Tasks-Completion-Reinforcement

Primary proximal outcome: whether the survey and/or active tasks were fully completed on the following day (binary).

Independent variable: offering a life-insight vs. not offering a life-insight after active tasks are completed (binary).

Control Covariates:

1. whether the survey and/or active tasks were fully completed the prior day (binary)
2. whether staff text or phone calls were made [to participants] in the last 30 hours [prior to time T where T = time of randomization, time of active task completion, or 6PM of current day] (binary) ⁴
3. app usage outside of survey/task completion: whether the app was opened in the prior 80 hours [prior to time T where T = time of randomization, or time of active task completion, or 6PM of current day] outside of when survey and/or active task were completed (binary) ⁵

2 Background on Data Storage and Transmission

All participants enrolled in the study were asked to install an aquarium app on their phone where they complete surveys and active tasks and view any engagement prompts offered. In addition to the aquarium app, participants whose mobile phones had an Android operating system were asked to install a data collection app that performs the randomizations to the engagement prompts and acts as a conduit in transmitting app usage data from a mobile phones SD card to the cloud. Participants whose mobile phones had an iOS operating system were not asked to install the data collection app (the system of storing and transmitting data in iOS did not involve a data collection app). Missing data can occur when the system of data storage and transmission does not function as planned (e.g. app crashes due to a bug, transmission of data between apps and the cloud fails). Below, we summarize the location of data storage and mode of data transmission by mobile phone operating system. The goal of the summary below is to facilitate better understanding of the missing data types and sources discussed in this article and in [1].

⁴30 hours is used for the same reasons as Aim 2.

⁵80 hours is used for the same reasons as Aim 2.

Table 1: Location of data storage and mode of data transmission by mobile phone operating system

Mobile Phone Operating System					
Location	iOS		Android		
	Aquarium App (Phone)	Cloud (Web)	Aquarium App (Phone)	Data Collection App (Phone)	Cloud (Web)
Records of Aim 1 Intervention Assignment (4PM Notification)	-	Randomization occurs in the cloud. Participants are randomized and their assignment is stored in the cloud even if they uninstall both apps. No transmission of assignment data from aquarium app to cloud occurs.	-	Randomization occurs in the data collection app. Participants are randomized only if they have the data collection app installed. Assignment is reported to the cloud directly from the data collection app.	Receives and stores assignment reported by the data collection app.
Records of Aim 2 Intervention Assignment (Memes) and Aim 4 Intervention Assignment (Life Insights)	Randomization occurs in the aquarium app. Assignment is reported to the cloud directly from the aquarium app.	Receives and stores assignment reported by the aquarium app.	Randomization occurs in the aquarium app. Assignment is reported to the cloud directly from the aquarium app.	-	Receives and stores assignment reported by the aquarium app.
Records of App Usage	Records are reported to cloud directly from the aquarium app.	Receives and stores records of app usage reported by the aquarium app.	Records are stored in the SD card. If SD card access is not given to aquarium app then no app usage file will be recorded.	Data collection app takes SD card app usage files and uploads them to the cloud. If SD card access is not given by the participant to data collection app then no app usage file will be uploaded to the cloud.	Receives and stores records of app usage reported by the data collection app.
Records of Whether Surveys are Completed	Survey completion occurs in aquarium app. Response to survey is reported to the cloud directly from the aquarium app.	Receives and stores survey completion data reported by the aquarium app.	Survey completion occurs in aquarium app. Response to survey is reported to the cloud directly from the aquarium app.	-	Receives and stores survey completion data reported by the aquarium app.
Records of Whether Active Tasks are Completed	Active task completion occurs in aquarium app. Response is reported to the cloud directly from the aquarium app.	Receives and stores active task completion data reported by the aquarium app.	Active task completion occurs in aquarium app. Response is reported to the cloud directly from the aquarium app.	-	Receives and stores active task completion data reported by the aquarium app.

3 Data Exclusion Criteria

3.1 Defining Study Day 1

For data analysis purposes in all aims, we decided to define Day 1 to be the first full day in the study (we define Day 0 as the day in which the participant was recruited; Day 0 will not be included in the analyses). By doing so, we have at most 29 (instead of 30) days of data per participant. In addition (relevant for constructing control covariates in all aims), the start of the study clock is therefore 12AM of Day 1. **Rationale:** Participants were recruited into the study at varying times on Day 0. For participants who were recruited after 4PM, the first time they could be randomized to the 4PM intervention assignment was the day following Day 0.

3.2 Data Excluded from Analyses in All Aims

74 participants were recruited to the study. However, data from participants not adhering to study protocol or requesting to discontinue participation during the study were excluded.

1. Data from days 1-29 (i.e. all data) from three participants

Rationale: Although these users did report owning an Android or iPhone smartphone on our screening survey (which is how they screened in to the study), they were best able to download the app onto an iPad for various reasons (e.g., they didn't have access to their phone in the ED). Recruitment protocol specifies Android and iPhone smartphones as inclusion criteria.

2. Data from days 1-29 (i.e. all data) from three participants

Rationale: Although participants were supposed to complete their first survey or active task as part of the intake visit, it wasn't required in order to be included in the study. Participants were excluded from the study if they didn't download the app on their smartphone as part of the intake visit.

3. Data from days 12-29 from one participant

Rationale: This participant refused to continue in the study on Day 12; hence can be viewed as not consenting to be part of the study from day 12 through 29. This participant didnt request that we disregard all data collected before he withdrew from the study.

3.3 Data Excluded from Analyses in Specific Aims

1. Aim 2 and 4: Since outcome on Day t is whether participant completed survey/active tasks on Day t+1, we do not have an outcome on Day 11 for participant described in Section 2.2 #3, or Day 29 for the remaining participants. **Decision:** We drop Day 11 for participant described in Section 2.2 #3 and drop Day 29 for the remaining participants.
2. Aim 4: Randomization to life insights began on Day 3. **Decision:** We drop Days 1-2 from Aim 4 analyses.
3. Aims 2 and 4: During the study, there was a bug causing the aquarium app to crash and affecting the delivery of memes. This bug also impacted participant’s ability to receive life insights. For Aim 2, 18 participants and 314 participant days between Days 1-28 were impacted (See Table 2 in [1]). For Aim 4, 16 participants and 279 participant days between Days 3-28 were impacted (See Table 3 in [1]). **Decision:** We perform the following analyses:

- *Main analysis:* For each of the 18 participants impacted by the bug, exclude all 28 days (i.e., exclude these 18 participants) from main analysis. A total of 50 participants will be included in the Aim 2 and Aim 4 analyses; participant described in 3.2#3 is not among the 50 participants since s/he was affected by the bug.
- *Sensitivity analysis (Performed on Aim 2 only):* Conduct Aim 2 analysis excluding only those 314 participant days impacted by the bug. 63 participants will be included (4 participants have all 28 days impacted by the bug, and participant described in 3.2#3 has all 10 days impacted by the bug); total of 1572 participant days. See sensitivity analysis results in [4].

3.4 Total Number of Participant Days to be Included in Main Analyses

Table 2: Aim 1

	No. of Participants (N)	No. of Participant Days (D)
Original Sample	74	$74 \times 30 = 2220$
Dropped Due to Ineligibility	$6 + 1 = 7$	$6 \times 30 + 1 \times (30 - 12) = 198$
Subtotal	$67 + 1 = 68$	$67 \times 30 + 1 \times 12 = 2022$
Dropped Day 0	$67 + 1 = 68$	$67 + 1 = 68$
Total	$67 + 1 = 68$	1954
Among Total:		
Participant Days Not Available		Among the 1954: 66
Participant Days Available		$1954 - 66 = 1888$
Among Available in Total:		
Missing Intervention Assignment		Among the 1888: 108 (Imputed)
Not Missing Intervention Assignment		$1888 - 108 = 1780$

Table 3: Aim 2

	No. of Participants (N)	No. of Participant Days (D)
Original Sample	74	$74 \times 30 = 2220$
Dropped Due to Ineligibility	$6 + 1 = 7$	$6 \times 30 + 1 \times (30 - 12) = 198$
Subtotal	$67 + 1 = 68$	$67 \times 30 + 1 \times 12 = 2022$
Dropped Day 0	$67 + 1 = 68$	$67 + 1 = 68$
Subtotal	$67 + 1 = 68$	1954
Dropped Last Day	$67 + 1 = 68$	$67 + 1 = 68$
Subtotal	$67 + 1 = 68$	1886
Dropped due to Bug Affecting Delivery of Memes	$17 + 1 = 18$	$17 \times 28 + 1 \times 10 = 486$
Total	50	$1886 - 486 = 1400$
Among Total: Participant Days Not Available Participant Days Available		Among the 1400: 521 $1400 - 521 = 879$
Among Available in Total: Missing Intervention Assignment Not Missing Intervention Assignment		Among the 879: 21 (Imputed) $879 - 21 = 858$

Table 4: Aim 4

	No. of Participants (N)	No. of Participant Days (D)
Original Sample	74	$74 \times 30 = 2220$
Dropped Due to Ineligibility	$6 + 1 = 7$	$6 \times 30 + 1 \times (30 - 12) = 198$
Subtotal	$67 + 1 = 68$	$67 \times 30 + 1 \times 12 = 2022$
Dropped Day 0	$67 + 1 = 68$	$67 + 1 = 68$
Subtotal	$67 + 1 = 68$	1954
Dropped Last Day	$67 + 1 = 68$	$67 + 1 = 68$
Dropped Days 1-2	$67 + 1 = 68$	$67 \times 2 + 1 \times 2 = 136$
Subtotal	$67 + 1 = 68$	1750
Dropped due to Bug Affecting Delivery of Memes	$17 + 1 = 18$	$17 \times 26 + 1 \times 8 = 450$
Total	50	$1886 - 486 = 1300$
Among Total: Participant Days not Available Participant Days Available		560 $1300 - 560 = 740$
Among Available in Total: Missing Intervention Assignment Not Missing Intervention Assignment		Among the 740: 37 (Imputed) $740 - 37 = 703$

4 Decisions on Construction of Outcome Variable

This section documents decisions on the construction of the outcome variable for Aims 1, 2, and 4.

Background: When a participant loses their log-in credentials to the SARA app, participants need to contact study staff to be able to regain access; the app was designed in such a way that recovery of log-in credentials cannot be accomplished using the app alone. In addition, participants have access to contact details of study staff should they lose their access to the SARA app/s through other means, such as a participant losing their phone.

1. **Construction of Aim 1 outcome variable “whether the survey and/or active tasks were fully completed in the evening of the same day”:** This outcome variable (`isCompleted` in the dataset) has two levels, 1 \rightarrow if we have indication that the participant completed the survey and/or active tasks on a given day; and 0 \rightarrow otherwise.
 - **Issue and decision:** If the participant lost access to the aquarium app, we assign the value 0 to this variable unless we had indication (based on reports by study staff) that the participant contacted study staff to regain access, in which case we assign the value 1 to this variable on days after the issue was reported up to when the issue was resolved. If, on a given day, study staff resolved the app access issue before 10PM, but the participant did not complete survey/active tasks for that day, then we set value of this variable on that day to 0. If, on a given day, study staff resolved the issue after 10PM (but before midnight), we set the value of this variable on that day to 1. **General rationale:** We assume that making an effort to report an app access issue is an indicator of engagement. **Rationale for selecting 10PM as threshold:** Survey/active task reminders (text messages from staff) were protocolled to happen between 9PM - 10PM each night, since study staff decided this time window would still give participants enough time to complete their survey/active task after receiving a reminder from study staff before data collection closed at 12AM. Applying the same logic to the app access issues, 10PM would be the latest that study staff could resolve an app issue while still allowing a participant to have enough time to complete their survey/active task. **No. of participants and days impacted:** 5 participants and 10 participant days within days 1-29 (See Table 5 in [1])
2. **Construction of Aim 2 and Aim 4 outcome variable “whether the survey and/or active tasks were fully completed on the following day”:** This outcome variable (`isCompleted_tomorrow` in the dataset) has two levels, 1 \rightarrow on a given day, if we have indication that the participant completed the survey and/or active tasks on the following day; and 0 \rightarrow otherwise. Similar to Aim 1, the outcome variable in Aim 2 and Aim 4 was also impacted by app access issues and an analogous decision for Aim 2 and Aim 4 was made.
 - **No. participants and days impacted:** Aim 2: 4 participants and 9 participant days within days 1-28 (See Table 6 in [1]); Aim 4: 4 participants and 9 participant days within days 3-28 (See Table 7 in [1])
3. **Interpretation of Aim 1 outcome on last day of the study – Day 11 for participant described in 3.2#3 and Day 29 for the remaining participants:**
 - **Issue:** On these days, survey completion data or active task completion data in the aquarium app may not have been uploaded to the cloud. When this occurs, survey completion and active task completion in the raw data may be recorded as a ‘0’ even if participant completed them. On the last day of the study, a ‘0’ in survey completion in the raw data means that it is unknown whether participant completed the survey on that day. Similarly, a ‘0’ in active task completion in the raw data means that it is unknown whether participant completed active tasks on that day.
 - **No. participants and days impacted:** This impacted at most 34 participant days (conservative): On Day 11, participant described in 3.2#3 did not complete survey and active tasks. For all other participants on Day 29, 33 out of 67 participants did not complete survey and active tasks, 4 out of 67 participants completed the survey but did not complete the active tasks, and

30 out of 67 participants completed survey and active tasks.

- **Additional background:** It is possible but unlikely that this issue could have occurred on Days 1-28, for survey completion data and active task completion data. The impact of this issue on the raw data on Days 1-28 is mitigated by:

- **Additional layer of verification through study staff contacting participants during the study:** study staff base decisions on whether or not to contact participants on survey and active task completion data (coming from aquarium app) during the study. Study staff report that there have seldom been inconsistencies in survey or active task completion data and actual participant survey or active task completion (verified upon contact) between Days 1-28.
- **Multiple opportunities for data syncing on Days 1-28: Data is sequentially synced from the app to external servers in the following order:** (1) survey completion, (2) meme randomization, (3) active task completion, (4) life-insight randomization. When survey or active task completion data fails to be uploaded on a given day, another attempt is made by the app to upload this data on the following day. Since Day 29 is the last day of the study, a failure to upload survey or active task completion data on Day 29 means that another attempt to do so on the following day cannot be made.

- **No direct means to distinguish between these two situations:** App usage data can be indicative but not conclusive for all participant days that could have been affected by this issue: After completion of survey [active task], participants were randomized to either receive or not receive after survey completion reinforcement [after active task completion reinforcement]. If there is a record of the participant receiving after survey completion reinforcement [after active task completion reinforcement] in the app usage raw data, then this is indicative of the participant completing the survey [active task]. However, if a participant was not randomized to receive after survey completion reinforcement [after active task completion reinforcement], then we cannot use the app usage raw data to provide an indication of survey completion [active task completion]. Further, if participant did not provide aquarium app access to data recorded in the participants phone SD card (where app usage data is stored), then regardless of randomization assignment to after survey completion reinforcement [after active task completion reinforcement], app usage data will have no record of app activity on days when access to phone SD card was not granted to the aquarium app.

- **Decision:**

- *Main analysis:* In main analysis, we will provide main analysis where we treat the cases on Day 29 in which the outcome is unknown as ‘no completion’ (this is a conservative approach).
- *Sensitivity analysis:* We will conduct sensitivity analysis where Day 29 is deleted. See sensitivity analysis results in [4]

4. **Interpretation of Aim 2 and Aim 4 outcome on Day 10 and Day 28:** Similar to Aim 1, the outcome variable in Aim 2 and Aim 4 was also impacted by data upload issues and an analogous decision for Aim 2 and Aim 4 was made. This impacted at most 34 participant days (conservative) in Aim 2 and Aim 4.

- **Decision:**

- *Main analysis:* In main analysis, we will provide main analysis where we treat the cases on Day 28 in which the outcome is unknown as ‘no completion’.
- *Sensitivity analysis (Performed on Aim 2 only):* We will conduct sensitivity analysis where Day 28 is deleted with the 50 participants unaffected by the bug impacting the delivery of memes. See sensitivity analysis results in [4]

5. **Construction of control variable “whether the survey and/or active tasks were fully completed the prior day”:** This variable (`isCompleted_yesterday_yes` in the dataset) has two levels:

1 → if there is any indication of the participant completing survey or active tasks on prior day; and 0 → otherwise.

- **Operationalizing this control variable on Day 1:** For participants who complete survey or active tasks on Day 0 (recruitment day), the value of this control variable for these participants on Day 1 is 1. Otherwise, the value of this control variable on Day 1 is 0. In other words, we are collapsing the following types of participants into one category: (1) participants who were recruited prior to 4PM (time of randomization to Aim 1 intervention) on Day 0 and did not complete daily survey or active tasks and (2) participants who were recruited after 4PM on Day 0 and did not complete daily survey or active tasks.
- **No. of participants impacted:** Aim 1: Among the 68 participants included in Aim 1 analysis, 10 did not complete survey and active tasks on Day 0; Aim 2: Among the 50 participants included in Aim 2 analysis, 6 participants did not complete survey and active tasks on Day 0; Aim 4: Analogous to Aim 2, among the 50 participants included in Aim 4 analysis, 6 participants did not complete survey and active tasks on Day 0. However, note that Aim 4 analysis begins on Day 3. On Day 3, `isCompleted_yesterday_yes` is constructed using survey/active task completion on Day 2.
- **Other related variables:** Two related variables not used in data analysis in [3] were also constructed for the dataset: `isCompleted_yesterday_no` and `isCompleted_yesterday_unknown`:
 - `isCompleted_yesterday_no` has two levels: 1 → if any one of the following has occurred: (1) *Day 1* and if participant was recruited **before** 4PM on Day 0 and did not complete daily survey or active tasks (2) *Day 2 onward* and participant did not complete daily survey or active tasks on prior day; 0 → otherwise
 - `isCompleted_yesterday_unknown` has two levels: 1 → *Day 1* and if participant was recruited **after** 4PM on Day 0 and did not complete daily survey or active tasks; 0 → otherwise
- Section 3 in [1] provides summary statistics of `isCompleted_yesterday_yes`, `isCompleted_yesterday_no`, `isCompleted_yesterday_unknown`

5 Decisions Regarding Construction of Control Covariates

This section documents decisions on the construction of control covariates for Aims 1, 2, and 4.

5.1 Control Covariate: Whether staff text or phone calls were made in the last X hours prior to time T

1. **Modes of contact used to construct variable for all aims:** To construct this control variable we included any form of contact by study staff, including emails or social media messages (not only text messages and phone calls).
2. **Records of contact used to construct this control variable for all aims:** To construct this variable, we considered multiple emails or messages belonging to the same conversation as distinct instances of contact at different times. In other words, to construct this variable we use all recorded timestamps of emails or messages sent to participants within a conversation, not only the timestamp of first contact in a given conversation.
3. **Operationalizing X and T for Aim 1:** X = 72 hours and T = 4PM on a given day.
4. **Operationalizing X and T for Aim 2:** X = 80 hours and T is determined by a rule.
 - **Background for Aim 2:** Even when a participant is available for Aim 2 intervention, s/he may not have a timestamp for the time of randomization to memes due to issues 9-10 described in [1], or a timestamp for when daily survey was completed. In addition, there may be more than one timestamp associated with daily survey completion on a given day. We address this via the rule below.
 - **Rule to determine T for Aim 2:**
 - Step 1:** Check if timestamp of time of randomization to meme/GIF exists. If yes, use this timestamp as T to construct covariate; if no, proceed to next step.
 - Step 2:** Check if timestamp of when daily survey was completed exists. If yes, check if there is more than 1 timestamp on a given day. If no daily survey completion time stamp exists, proceed to next step.
 - Step 2a:** If there is more than 1 daily survey completion time stamp, choose earliest timestamp as T to construct covariate.
 - Step 2b:** If there is only 1 daily survey completion time stamp, use this time stamp as T to construct covariate.
 - Step 3:** If both time of randomization to meme/GIF and time of survey completion are unknown, use 6PM of a given day as T to construct this covariate.
5. **Operationalizing X and T for Aim 4:** X = 80 hours and T is determined by a rule.
 - **Background for Aim 4:** Even when a participant is available for Aim 4 intervention, s/he may not have a timestamp for the time of randomization to life insights due to issues 11-12 described in [1], or a timestamp for when active tasks were completed. In addition, there may be more than one timestamp associated with completion of active tasks on a given day. We address this via the rule below.
 - **Rule to determine T for Aim 4:**
 - Step 1:** Check if timestamp of time of randomization to life insights exists. If yes, use this timestamp as T to construct covariate; if no, proceed to next step.
 - Step 2:** Check if timestamp of when active tasks was completed exists. If yes, check if there is

more than 1 timestamp on a given day. If no active task completion time stamp exists, proceed to next step.

Note on Step 2: As participants need to complete two active tasks, we only consider the time after the second active task was completed.

Step 2a: If there is more than 1 active task completion timestamp, choose latest timestamp as T to construct covariate.

Step 2b: If there is only 1 active task completion timestamp, use this time stamp as T to construct covariate.

Step 3: If both time of randomization to life insights and time of completion of active tasks are unknown, use 6PM of a given day as T to construct this covariate.

6. **Number of levels of covariate:** The covariate (**contact_yes** in the dataset) has two levels: 1 \rightarrow we have clear evidence that study staff contacted participant in the past X hours from time T (evidence given by recorded timestamps of contact made by study staff to participants); 0 \rightarrow otherwise.

- **The ‘0’ category:** Category 0 includes participant days that could be considered as a separate category labeled as ‘unknown’. In the current analysis, we use the two labels 0/1 described above even if the time elapsed between 12AM of Day 1 (study start from the purpose of data analysis) and T on a given day is less than X hours. To clarify this, consider Aim 1. On day 2 less than 24 hours has elapsed between 12AM of Day 1 and 4PM of Day 2. In this case, if there is no evidence in our records that the participant was contacted by study staff since the beginning of the study (i.e. since 12AM on day 1) we include this case in the 0 category (i.e. we set the value of this control variable to 0). If our records indicate that the participant was contacted by study staff during that time, we set the value this control variable to 1.
- **Other related variables:** Two related variables not used in data analysis in [3] were also constructed for the dataset: **contact_no** and **contact_unknown**:
 - **contact_no** has two levels: 1 \rightarrow *time elapsed between 12AM of Day 1 and T on a given day is at least X hours* and no evidence in our records that the participant was contacted by study staff since the beginning of the study; 0 \rightarrow otherwise
 - **contact_unknown** has two levels: 1 \rightarrow *time elapsed between 12AM of Day 1 and T on a given day is less than X hours* and no evidence in our records that the participant was contacted by study staff since the beginning of the study; 0 \rightarrow otherwise
- Section 3 in [1] provides summary statistics of **contact_yes**, **contact_no**, and **contact_unknown**

5.2 Control Covariate: Whether the app was opened in the prior X hours prior to time T outside of when survey and/or active task were completed

1. **Operationalizing X and T:** X and T were operationalized in the same manner for all aims as in 5.1.
2. **Operational definition of opening the app outside of survey or active task completion:**
 - **Background:** In general these cases include any app activity not associated with (i) attempting to complete (not necessarily completing) the daily survey or active tasks, (ii) any required interaction with the app due to attempting to complete the daily survey or active tasks, or (iii) the app running

in the background of a users phone but do not correspond to the user actively engaging with the app.

- **Data used to construct covariate:** Raw data used to construct this variable are csv files (one for each participant) containing specific app activity (e.g. specific page in the app that was viewed, going in and out of the app) and a timestamp corresponding to the date and time of these events. If any of the 6 criteria specified below are met, we view a given recorded app activity in the raw data as representing (i), (ii), or (iii). If a participant has any recorded app usage data in the past X hours from time T of a given day that **does not meet any of the criteria described below**, then the participant is viewed as having opened the app outside of daily survey or active task completion in the past X hours.

Criterion 1: A direct interaction with survey/tasks. This is operationalized as any view containing the key words (i.e. strings) “dailysurvey”, “weekly_survey”, “TappingTask”, “SpatialTask”, “ActiveTask”

Criterion 2: An interaction with the app occurring within 10 seconds of a direct interaction with survey/tasks; the goal is to exclude (from being considered as app usage outside of survey/task completion) interactions with the app that might be required as part (or are as a result) of survey/active tasks completion. This is operationalized as any app activity occurring within 10 seconds of view containing the key words “dailysurvey”, “weekly_survey”, “TappingTask”, “SpatialTask”, “ActiveTask”

Criterion 3: An app login activity: since both using the app outside of survey/task completion and using the app specifically for survey/task completion require logging into the app, we excluded app login activities from being considered as outside of survey/task completion. This is operationalized as (view, status) containing (login, start) or (login, destroy)

Criterion 4: Any interaction with the app occurring within 10 seconds of logging in the app; the goal is to exclude (from being considered as outside of survey/task completion) app interactions that are required following login. This is operationalized as any app activity occurring within 10 seconds of (view, status) containing (login, destroy). Note: The aquarium page is an example of a required interaction with the app after logging into the app (the app take the person straight to the aquarium page immediately after login). Interactions with the aquarium lasting longer than 10 seconds are viewed as engaging with the app outside of completing survey/tasks.

Criterion 5: Any app activity required to resume interaction with the app following a period of inactivity. This is operationalized as (view, status) containing (app, resume).

Criterion 6: Any interaction with the app occurring within 10 seconds of resuming interaction with the app. This is operationalized as any app activity occurring within 10 seconds of (view, status) containing (app, resume).

3. **Number of levels of covariate:** The covariate (**appusage_yes** in the dataset) has two levels: 1 → we have evidence that the participant opened the app outside of survey or active task completion in the past X hours from time T (evidence as described by 5.2#2); 0 → otherwise. As we discuss below, category 0 includes participant days that could be considered as a separate category labeled as

‘unknown’.

- **Background:** If a participant does not have any record of app activity in the raw data over a certain time period, this does not necessarily mean that the participant did not use the app during that period; it is possible that the participant used the app, but study team was unable to obtain a record of that app activity. Thus, when there is no record of app activity in the raw data over a certain time period, we need to determine whether this indicates no app activity or a missing record of app activity.
 - **Decision when there are no records of app usage in the raw data and there is an indication of lack of engagement:** When there is no record of app usage in the raw data and our records indicate that the participant uninstalled the data collection app (mobile phones with Android) or did not provide access to his/her mobile phones SD card (mobile phones with Android) we consider this time duration as having no app activity (see issues 6 and 7 in [1]). Note that with respect to the aquarium app there is no way for us to know if a participant (either an Android or iOS user) uninstalled this app if s/he did not contact study staff to regain access. In this case, what we will end up seeing in the raw data is no record of app usage which we consider here as no app activity.
 - **Decision when there are no records of app usage in the raw data and there is an indication of engagement:** When there is no record of app usage in the raw data and there are records of participants losing access to the aquarium app but contacting study staff to regain access, then we view this as having a missing record of app activity. (See issue 0 in [1]). In the current analysis, we include these cases in the 0 category, but they can also be treated as a third category (‘unknown’), as we discuss below.
- **Operationalizing this control variable when time elapsed between 12AM of Day 1 and T is less than X hours:** Note that this covariate is still defined to have two levels with the same labels as described above even if the time elapsed between 12AM of Day 1 (study start for the purpose of data analysis) and T on a given day is less than X hours. To clarify this, consider Aim 1. On day 2 less than 72 hours has elapsed between 12AM of Day 1 and 4PM of Day 2. In this case, if there is no evidence in our records that the participant opened the app outside of survey or active task completion since the beginning of the study (i.e., since 12AM on day 1) we include this case in the 0 category (i.e. we set the value of this control variable to 0). If our records indicate that the participant opened the app outside of survey or active task completion during that time, we set the value this control variable to 1.
- **Other related variables:** Two related variables not used in data analysis in [3] were also constructed for the dataset: **appusage_no** and **appusage_unknown**:
 - **appusage_unknown** has two levels: 1 \rightarrow if any one of the following has occurred (1) *time elapsed between 12AM of Day 1 and T on a given day is less than X hours* and there were no records of opening the app outside of survey or active task completion during this period (2) *time elapsed between 12AM of Day 1 and T on a given day is more than X hours* and there are no records of app usage but there is an indication of engagement; 0 \rightarrow otherwise
 - **appusage_no** has two levels: 1 \rightarrow if both `appusage_yes=0` and `appusage_unknown=0`; 0 \rightarrow

otherwise

- Section 3 in [1] provides summary statistics of `appusage_yes`, `appusage_no`, and `appusage_unknown`

6 Other

6.1 Construction of availability variable

This variable (**availability** in the dataset; A_{it} in [SARAAnalysis.pdf](#) [5]) has two levels: $1 \rightarrow$ if we consider a given participant day to be available for intervention, $0 \rightarrow$ if we consider a given participant day to be *unavailable* for intervention. Due to unanticipated technical issues outside of the participants control, there were days in which the delivery of the 4PM notification, memes, or life insights was not feasible. Those participant days were considered unavailable in the current analyses. Details regarding the number of unavailable days are provided in [1].

6.2 Missing intervention assignment

Details regarding number of participant days with missing intervention assignment are provided in are provided in [1] and plots of their missing data pattern are provided in [2].

6.3 Checks on Quality of Randomization

Checks on the quality of randomization for the SARA MRT are documented in [2]. To check quality of randomization, two sets of data were used: complete case data and one imputed dataset for each aim.

6.4 Data Analysis

Results of data analysis with complete case data and with multiply imputed data (10 imputed datasets) for each aim are provided in [3].

References

- [1] <https://github.com/jamieyap/SARA/blob/master/sara-tables-main.pdf>
- [2] <https://github.com/jamieyap/SARA/blob/master/check-randomization.pdf>
- [3] <https://github.com/jamieyap/SARA/blob/master/display-results.pdf>
- [4] <https://github.com/jamieyap/SARA/blob/master/display-sensitivity.pdf>
- [5] <https://doi.org/10.17605/OSF.IO/WHGFP>