# Pre-Registration
## *Random-Controlled Trial on the Effect of Induced Incidental Affect States [Fear/Happiness] on Privacy Behavioural Intentions*[*]

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## General Purpose of Pre-Registrations

Pre-registrations are research statements of intention established before a sample is evaluated and statistical inferences are undertaken. A pre-registration asserts the aim of a study, including its research questions and statistical hypotheses, methods, incl. operationalization of independent variables (IVs) and dependent variables (DVs), sample and analysis specification.

The primary reason for a pre-registration lies in the fact that a statistical inference (Null Hypothesis Significance Testing) is only valid if the statistical hypotheses are fixed before the inference is undertaken. This is grounded in a $p$-value being a conditional likelihood contingent on the fixed null hypothesis assumed to be true. Furthermore, pre-registrations serve as a ward against questionable research practices, such as outcome-switching, hypothesizing after the results are known (HARKing), or $p$-hacking... it is meant to counteract the many temptations of researcher degrees of freedom.

Pre-registrations are typically committed confidentially under embargo, with an immutable timestamp. Once the corresponding study is published, the embargo is lifted.

This is an experiment registration form for the Open Science Framework (OSF)[1]. It is modelled according to the format of AsPredicted[2].

[*]Open Science Framework: `https://osf.io/c3jy8/`
[1]`https://osf.io`
[2]`https://aspredicted.org`

## Context of this Pre-Registration

**Meta-Data of Pre-Registration.**

- Open Science Framework Repository: `https://osf.io/c3jy8/`
- Registered Registration File: `https://osf.io/z985y/`—RCT_Impact_Affect_PBI_Mainstudy.pdf
- Timestamp: **2019-02-11 11:43 AM**
- Archived Immutable Pre-Registration: `https://osf.io/h3e4w`
- Timestamp: 2019-02-11 11:47 AM

**Peer-Reviewed Publication.** The definitive version of the study is published as:
Uchechi Phyllis Nwadike and Thomas Groß. Investigating the Effect of Incidental Affect States on Privacy Behavioural Intention. In Proceedings of the 9th International Workshop in Socio-Technical Aspects in Security (STAST'2019), LNCS 11739, Springer Verlag, 2020, pp. 181–204

**ArXiv Report.** Uchechi Phyllis Nwadike and Thomas Groß. Investigation of the Effect of Incidental Fear Privacy Behavioral Intention (Technical Report). arXiv:2007.08604, 2020. `https://arxiv.org/abs/2007.08604`

## 1 Structured Abstract

**Background.** Incidental emotions users feel during their online activities may alter their general stance on privacy behavioral intentions.

**Aim.** The aim of this study is to investigate to what extent an incidental affect state of induced happiness or fear causes differences in privacy behavioral intention.

**Method.** In a within-subjects random-controlled trial, $N = 60$ participants (in the lab and on MTurk each) are exposed to either a neutral state video, or—in randomly assigned order—standardized stimulus videos [5] inducing happiness or fear. As manipulation check, we measure the affect present in that moment with the Positive and Negative Affect Schedule (PANAS-X, 15-item version on fear and joviality) [6] and in the lab with affect recognition on face geometry from a video recording. We evaluate the mean difference of Privacy Behavioral Intention (PBI) [7] across fear and happiness conditions as well as a linear regression on reported fear and joviality on PBI.

**Anticipated Results.** We will obtain the results of dependent-samples $t$-tests and OLS linear regressions on the impact of affect on privacy behavioral intention, in addition to results on the manipulation check on the strength of the induced affect.

**Anticipated Conclusions.** We expect to learn how a current affect, even if it is incidental, that is, unrelated to the task at hand, influences privacy behavioral intention.

## 2 State of Data Collection

*Have any data been collected for this study yet?*
(a) □ data have been collected.
(b) Square Some data have been collected, but not analyzed.
(c) ☑ Some data have been collected and analyzed.

*If (b) or (c), please explain briefly:*
The research hypotheses for this experiment have already been established in 2016[3]. We have already started offline and online data acquisition. The data collected includes video recordings of participants' facial expressions, questionnaire responses to privacy concerns, privacy behavioral intentions, personality traits. However, at the time of this pre-registration the analyses for statistical inference have not been conducted, yet.

## 3 Aims

*Hypothesis: What's the main question being asked or hypothesis being tested?*

**Impact of Affect.** The study seeks to make a comparison of the influence of affect states on Privacy Behavioral Intention (PBI) [7].

**Research Question 1** (Impact of affect on PBI)**.** *To what extent does Privacy Behavioral Intention (PBI) [7] in the form of Information Disclosure Intention (IDI), Transaction Intention (TI) and Protection Intention (PI) change depending on induced incidental happiness and fear?*

This research question decomposes into multiple statistical hypotheses iterated over dependent variables (idi, ti, pi) pair-wise compared across conditions (neutral, happiness, fear). Hence, we obtain nine null and alternative hypotheses pairs for comparisons on: neutral–happiness (nh), neutral–fear (nf), happiness–fear (hf). In addition to that, we investigate the pair-wise comparison of the combined pbi scores across conditions.

As primary analysis, we are most interested in, we consider the combined Privacy Behavioral Intention (PBI) score pbi in the comparison between the happiness–fear conditions.

**Null Hypothesis 1.** $\mathsf{H}_{\mathsf{hf,pbi},0}$ *There is no difference in privacy behavioral intentions scores (*pbi*) between cases with induced happiness and induced fear.*

[3] Reference provided on request

**Alternative Hypothesis 1.** $\mathsf{H}_{\mathsf{hf,pbi},1}$ *Privacy behavioural intention scores* pbi *differ between the conditions* happiness *and* fear *(*hf*).*

We consider the remaining pair-wise hypotheses as secondary. In terms of multiple-comparison corrections we will consider the primary hypothesis as standing on its own, all secondary analyses as a test family, which asks for corrections. The hypotheses are obtained iterating over

1. Conditions Comparisons *CC* :=
   (a) neutral–happiness (nh),
   (b) neutral–fear (nf),
   (c) happiness–fear (hf)
2. Dependent Variables *DV* :=
   (a) pbi: Combined Privacy Behavioral Intention (PBI) score,
   (b) idi: PBI Information Disclosure Intention (IDI) sub-scale score,
   (c) ti: PBI Transaction Intention (TI) sub-scale score,
   (d) pi: PBI Protection Intention (PI) sub-scale score.

**Null Hypothesis 2.** $\mathsf{H}_{CC,DV,0}$ *There is no difference in privacy behavioral intentions scores of scale DV between conditions specified in comparison CC.*

**Alternative Hypothesis 2** (Affect impact by *CC* and *DV*)**.** $\mathsf{H}_{CC,DV,1}$ *Privacy behavioural intention scores of scale DV differ between the conditions specified in comparison CC.*

Note that *CC* and *DV* are variables that take values $(\mathsf{nh},\mathsf{nf},\mathsf{hf})$ and $(\mathsf{pbi},\mathsf{idi},\mathsf{ti},\mathsf{pi})$ as specified above. They thereby define a test family of 12 alternative and null hypothesis pairs.

**Manipulation Check.** Of course, we evaluate to what extent the affect induction was successful and in what magnitude the affect of the participants has changed after our induction.

We have three measurement instruments to control the participants affect state: the Positive and Negative Affect Schedule (PANAS-X) [6], the NOLDUS Facereader (FR, offline only) [1], and the Microsoft Emotional Recognition (ER, offline only).

A manipulation is considered successful if the following null hypotheses can be rejected (Iterated over the measurement instruments $MC \in \{\mathsf{px},\mathsf{fr},\mathsf{er}\}$.

**Null Hypothesis 3.** $\mathsf{H}_{MC,\mathsf{jov},0}$ *There is no difference in MC-measured joviality between happiness and fear conditions.*

**Alternative Hypothesis 3** (Affect impact by *CC* and *DV*)**.** $\mathsf{H}_{MC,\mathsf{jov},1}$ *The MC-measured joviality differs between happiness and fear conditions.*

**Null Hypothesis 4.** $\mathsf{H}_{MC,\mathsf{fear},0}$ *There is no difference in MC-measured fear between happiness and fear conditions.*

**Alternative Hypothesis 4** (Affect impact by *CC* and *DV*)**.** $\mathsf{H}_{MC,\mathsf{fear},1}$ *The MC-measured fear differs between happiness and fear conditions.*

Here, we consider the PANAS-X (px) measurement as the authoritative manipulation check and fr and er as complementary.

**Regression Model.** We are interested in the relation between Privacy Behavioral Intention $(\mathsf{pbi},\mathsf{idi},\mathsf{ti},\mathsf{pi})$ and measured affect PANAS-X (pxjov and pxfear).

**Research Question 2** (Relation of measured affect and PBI)**.** *To what extent is there a linear relationship between the reported affect state (PANAS-X) and the PBI scales.*

We consider the following hypotheses for an overall model, with canonical hypotheses for the respective predictors.

**Null Hypothesis 5.** $\mathsf{H}_{\mathsf{px,pbi},0}$ *There is no linear relationship between measured affect and PBI scores.*

**Alternative Hypothesis 5.** $\mathsf{H}_{\mathsf{px,pbi},1}$ *There is a systematic linear relationship between measured affect and PBI scores.*

We note that the overall PBI score relation is designated as primary hypothesis and the PBI-subscale relations designated as secondary hypotheses.

# 4 Methods

We conduct two studies within online and offline settings.

**Common Aspects.** Both studies consist of four parts: a) participant registration (incl. demographics and personality/privacy trait questionnaires), b) a control PBI session with a neutral video, c) first PBI session with a randomly chosen stimulus video (happy/fearful), d) second PBI session with the complementary stimulus video (fearful/happy). Both studies are thereby within-subject randomized controlled trials with a random assignment of participants to an order either (1. happy, 2. fearful) or (1. fearful, 2. happy).

**Differences.** The difference between the studies are: a) online participants completed a combination of the pre-task survey and the first phase of the study on the same day while in the offline study the participants completed the registration before stating the main study. b) The second difference is no video recording was conducted with the online participants while we video recorded the facial expressions of the offline participants. c) The online study uses as assignment a simple uniform random assignment. d) The offline study uses a constrained random assignment maintaining a balance between stimulus orders.

## 4.1 Procedure

The procedure of the study is as follows: First the participants indicated their interest in a registration(pre task) form containing questions on privacy concerns, personality traits; The study was spread over two days; in the first day, the participants carried out the following steps, i.e. 2-3. On the second day, the participants were first induced to a neutral state and then they completed steps 4 and 5. The reason for this was to minimize the carryover effects of the video stimuli and effect of questionnaire fatigue.

The procedure consists of the following steps, where Fig. 2 illustrates the key elements of the experiment design:

1. Completion of pre-task questionnaire on demographics, alcohol/recreational drug use, IUIPC and CFIP surveys.
2. Neutral state.
   (a) Induction of a neutral baseline affect state,
   (b) DV questionnaires on privacy behavioral intentions,
   (c) Manipulation check with PANAS-X,
   (d) (Offline only) Manipulation check: Emotional Recognition (ER) and Facereader (FR) from video recording of the participant's face geometry.
3. Affect State 1: Either happy or fearful, determined by random assignment.
   (a) Show video stimulus to induce affect.
   (b) DV questionnaire on privacy behavioral intentions,
   (c) Manipulation check with PANAS-X.
   (d) (Offline only) Manipulation check: Emotional Recognition (ER) and Facereader (FR) from video recording of the participant's face geometry.
4. Affect State 2: Complement of Affect State 1.
   (a) Show video stimulus to induce affect.
   (b) DV questionnaire on privacy behavioral intentions,
   (c) Manipulation check with PANAS-X.
   (d) (Offline only) Manipulation check: Emotional Recognition (ER) and Facereader (FR) from video recording of the participant's face geometry.
5. a debriefing questionnaire, used to check for missed or misreported information, subjective thoughts during study session.

## 4.2 Manipulation Check

We checked the manipulation against self-report and psycho-physiological measurement tools:

a) 15-item PANAS-X [6] (joviality and fear) with a designated time horizon "at this moment."
b) (offline only) Facereader FR [1] (happiness and fear),
c) (offline only) Emotional Recognition ER (happiness and fear).

We note that from pre-tests we have found that FR and ER data is not normally distributed, hence need to use non-parametric tests evaluating the manipulation check on them.

## 4.3 Attention Check

Attention check questions were embedded in the questionnaires to ensure that the participants paid adequate attention and did not complete the questionnaire arbitrarily. These attention checks are Instructional Manipulation Checks (IMC) [4]. The entries with wrong responses to the attention check questions will be excluded [3].

## 4.4 Random Assignment and Blinding

In the online case, participants are randomly assigned across the two conditions of the experiment using a uniform pseudorandom function. Blinding is applied in that participants are not informed about the purposes of the experiment, even though they of course note the different videos observed. The experimenter is not aware of the stimuli given to participants as they go through their sessions.

In the offline case, participants are assigned with a constrained random assignment across affect conditions (happy and fearful), that is, it is assured that the order of stimuli given to the participants is roughly balanced. Here only the purposes of the experiment are hidden from the participant, but the experimenter administrating the experiment is aware of stimuli given, and thereby the experiment conditions.

# 5 Independent Variables (IVs)

*Describe the conditions (for an experimental study) or predictor variables (for a correlation study).*

The independent variable (IV) is a condition of induced affect with three levels: (a) neutral baseline, (b) happy, and (c) fearful.

The conditions are induced with vetted stimulus videos [5], notably

1. neutral: *Alaska's Wild Denali* (Alaska Tavel Guide on Denali's landscapes and wildlife)
2. happy: *When Harry met Sally* (Restaurant scene)
3. fearful: *The Shining* (Breaking through door scene)

# 6 Dependent Variables (DVs)

*Dependent variables: Describe the key dependent variable(s) specifying how they will be measured.*

Dependent variables: Scores of the Privacy Behavioral Intention [7] with a combined score (pbi), a sub-scale on Information Disclosure Intention (idi), a sub-scale on Transaction Intention (ti) and a sub-scale on Protection Intention (pi).

# 7 Mediator Variables

*Describe any variables you expect to mediate the relationship between your IV's and DV. Specify how they will be measured.*

N/A

# 8 Moderator Variables

*Describe any variables you expect to moderate the relationship between your IV's and DV. Specify how they will be measured.*

Trait-like privacy concerns (IUIPC [2] and CFIP) comparable to subjective norms and Big Five personality traits (BFI).

## 9 Data Preparation

*Describe what measures will be taken to check assumptions and label outliers.*

**Response Coding.** The survey responses will be coded and assigned numerical equivalent. Take for instance *Strongly Disagree* will be assigned the value 1; *Disagree* will be assigned 2; *Somewhat Disagree* – 3; *Neither Disagree nor Agree* – 4; *Somewhat Agree* – 5; *Agree* – 6; and *Strongly Agree* – 7.

**Incomplete Cases.** Incomplete survey responses and those with wrong responses to the attention check questions will be excluded. Incomplete questionnaires will be excluded.

**Video Processing.** The video stream will serve as input for Facereader (FR), a still image of the said face-recording will be taken at the end of the corresponding stimulus and used as input for Emotional Recognition (ER).

**Outlier Treatment.** The data will be checked for outliers using the robust outlier labeling rule with $1.5 \cdot \mathsf{IQR}$ and $3 \cdot \mathsf{IQR}$ as inner and outer fences, the typical setup for the R package car (Boxplot).

We endeavour not to exclude outliers per se, but to cap them at the 95 or 5 percentile, if the statistical test requires outlier treatment to be robust.

## 10 Main Analyses

*Describe what analyses (e.g. t-test, repeated-measures ANOVA) you will use to test your main hypotheses.*

**Difference Across Conditions.** Properties of the sample permitting, we intend to compute two-tailed dependent-samples *t*-tests at a significance level of $\alpha = .05$ as tool of choice to test for the difference between means of the conditions.

These tests will also be used for the manipulation checks on PANAS-X.

However, Facereader (FR) and Emotional Recognition (ER) manipulation check results are usually not normally distributed, by which we would opt for a two-tailed matched-pairs Wilcoxon Signed-Rank test at significance level $\alpha = .05$ as non-parametric alternative.

**Regression Model.** We intend to regress the Dependent Variables (DVs) of Privacy Behavioral Intention $(\mathsf{pbi}, \mathsf{idi}, \mathsf{ti}, \mathsf{pi})$ onto the affect measured with PANAS-X (pxjov and pxfear), considering privacy concerns (IUIPC and CPFI) and Big Five (BFI) as co-variates, further controlling for the source of data (Lab/MTurk).

The primary model is meant to be:

$$\mathsf{pbi} \sim \mathsf{pxjov} + \mathsf{pxfear} + \mathsf{iuipc}[3] + \mathsf{bfi}[5] + \mathsf{source},$$

with

$$\mathsf{pbi} \sim \mathsf{pxjov} + \mathsf{pxfear}$$

as core relation of interest.

We consider as secondary models with the PBI sub-scale scores as DV and the same structure: idi, ti, pi.

We note here that the data is from dependent-samples, by which, we need to conduct a mixed-methods regression with the subject as random factor.

## 11 Secondary Analyses

*Describe what secondary analyses you plan to conduct (e.g., order or gender effects).*

We intend to check for order effects, that is, whether it makes a difference whether a participant has been exposed to a given stimulus first or second.

We intend to conduct a test for differences between the online and offline studies. These differences are considered on the manipulation check (i.e., the magnitude of the induced affect) and the PBI.

We consider exploratory correlation analysis between demographic variables and PBIQ scores, privacy concerns and big five personality traits.

## 12 Validation

**RCT Properties.** We check for a random distribution of demographics across the assignment to condition orders to validate the random assignment. If the random assignment was correct, we would expect not to find any statistical difference of demographics across condition orders.

**Model Diagnostics.** We are computing post-analysis regression diagnostics using the R package car, evaluating distribution of residuals, influential cases, variance inflation, etc.

**Prediction Accuracy.** We intend to compute a 10-fold cross-validation on the same data, to check for prediction accuracy of the linear regression.

## 13 Sample

Considering a within-subjects experiment design, in which all participants are exposed to a neutral control condition, an induced happiness condition as well as an induced fear condition, we make the following observations on the selected sample size of $N = 60$.

***t*-Test-Like Statistics.** In an *a priori* power analysis of a two-tailed dependent-samples $t$-test, $\alpha = .05$, power $1-\beta = .8$ and an effect size smaller than medium, Cohen's $dz = 0.4$ asks for a total sample size of $N = 52$.

For the two-tailed matched-pairs Wilcoxon signed-rank test with the same parameters ($\alpha = .05$, $1-\beta = .8$, $dz = 0.4$) we would need a total sample size of $N = 54$.

Hence, both individual studies separately could well detect medium effects at 80% power with $N = 60$, notably having a sensitivity of Cohen's $dz = 0.377$ on the signed-rank test at that power ($dz = 0.49$ at 95% power).

We note that a between-subject study aiming at 80% power on the same effect size of Cohen's $d = 0.377$ on an two-tailed independent-samples $t$-test (with equal allocation ratio) would require a total sample size of $N_{\mathsf{IS}} = 224$ (without accounting for corrections).

Hence, designing this experiment as within-subjects gains us considerable additional power at the cost of the possibility of drop-outs, reduced attention, and order effects. This is especially important considering our lab study, in which participants would spend up to one hour in a controlled environment with video recording for their face.

**Multiple Comparison Corrections.** We note further that accounting for a Bonferroni multiple-comparisons correction on test families with 12 tests as proposed, we would have a corrected $\alpha_{\mathsf{MC}} = 0.00416$, at which the signed-rank tests could still account for medium effects of $dz = 0.508$ at 80% power.

**Linear Regression Model.** For the planned regression, we will combine both samples accounting for their source (Lab/MTurk) with a factor. The minimal regression with three predictors would yield a sensitivity of Cohen's $f^2 = 0.148$ at 95% power. A full regression with 12 predictors would yield a sensitivity of $f^2 = 0.237$ at 95% power and $f^2 = 0.159$ at 80% power. As comparison, Cohen's $f^2 = 0.15$ roughly corresponds to $R^2 = 13\%$ variance explained.

**Overall Sample.** Overall, we deem a sample size of $N = 60$ sufficient for the within-subjects study and a combined sample of $N = 120$ for the regression adequate.

## 14 Exclusion Criteria

*Who will be excluded (e.g., outliers, participant who fail manipulation check, demographic exclusions)? Will they be replaced by other participants?*

Participants who have mental health issues, cannot watch violent films, consumed drugs or alcohol are screened and replaced during the registration phase.

Participants who do not return for the second session will be excluded from the overall analysis without replacement.

Responses from participants who fail instructional manipulation check (IMC) questions are considered non-attentive and excluded without replacement.

## 15 Exception Handling

*Should exceptions from the planned study occur (e.g., unexpected effects observed), how will they be handled?*

Exceptions will be reported explicitly as such, unexpected effects reported as exploratory findings.

## 16 Sign-Off

Pre-registration written by (initials): U.N., T.G.

Pre-registration reviewed by (initials): T.G.

## Change Management

**2020-07-27:** The pre-registration was amended with author disclosure and project acknowledgment.

## Acknowledgment

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## References

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