

# Understanding Emotion Changes in Mobile Experience Sampling

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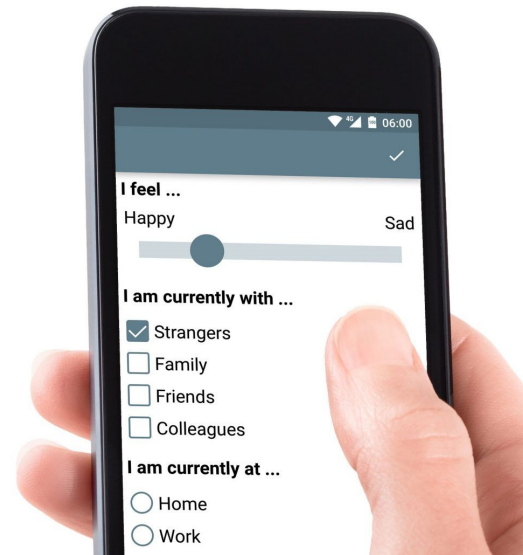
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# Background

- Trends: A wide range of information collection from people (e.g., health status, behavior patterns, psychological states)
- Needs: A naturalistic method to label those information
- Solution: Experience Sampling Method (ESM) [1]
  - Popular self-report method ( ↔ observation )
  - In-the-wild / in-situ / real-time / naturalistic assessment



# Motivation

**However,**

unexpected interruption by self-report requests can influence the respondent's psychological status [2].

- Does answering ESM survey affect people's emotional states? How much?
- Is there a validity issue to collect emotions by using the ESM?



# Research questions

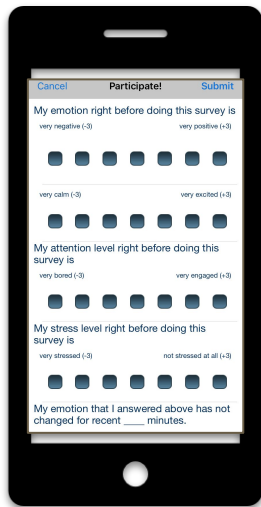
Exploring “**Emotion change**” phenomenon during ESM response task

**RQ1.** How ESM response tasks affect people’s emotional states

**RQ2.** What factors are related to emotion changes

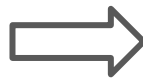
**RQ3.** What are typical contexts when emotion changes occur due to ESM response tasks in daily circumstances

# Study overview



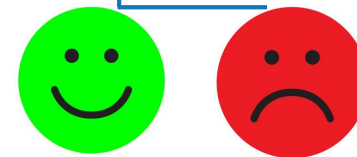
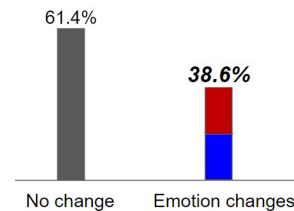
## Pilot study

- Questionnaire design
- ESM configuration



## Data collection

- Multi-modal sensors
- ESM labels

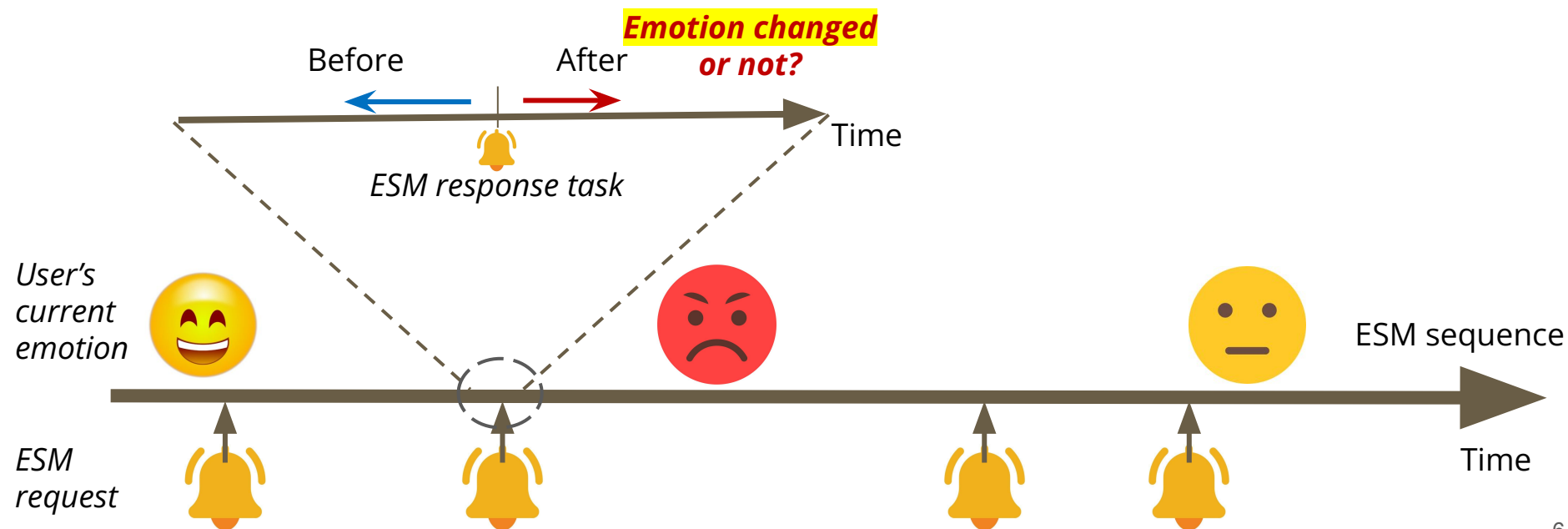


## Analysis

- # Emotion changes
- Contextual factors
- Real-life instances

# ESM design – Pilot study

Ask whether there were emotion changes during ESM response tasks



# ESM design – Questionnaire

*Distinguish the emotions **before** and **after** the ESM response*

**Q1&2.** My emotion right before doing this survey was

– Russell (1980)

very negative (-3) ~ very positive (+3)

**[Valence]**

very calm (-3) ~ very excited (+3)

**[Arousal]**

**Q3.** My attention level right before doing this survey could be rated as – Pielot et al. (2017)

very bored (-3) ~ very engaged (+3)

**[Attention]**

**Q4.** My stress level right before doing this survey was

– Thayer (1990)

not stressed at all (-3) ~ very stressed (+3)

**[Stress]**

**Q5.** My emotion that I answered above has not changed for recent \_\_\_\_\_ minutes.

5 10 15 20 30 60 min / I am not sure

**[Duration]**

**Q6.** Answering this survey disturbed my current activity

– Turner et al. (2015)

entirely disagree (-3) ~ entirely agree (+3)

**[Task disturbance]**

**Q7.** How did your emotions change while you are answering the survey now? – Turner et al. (2015)

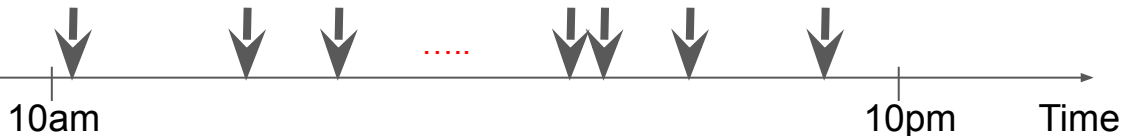
I felt more negative (-3) ~ I felt more positive (+3) **[Emotion change]**

# Data collection



**ESM surveys:**

16 random requests b/w 10AM~10PM (common settings as recent ESM studies)



## Dataset overview

### Participants

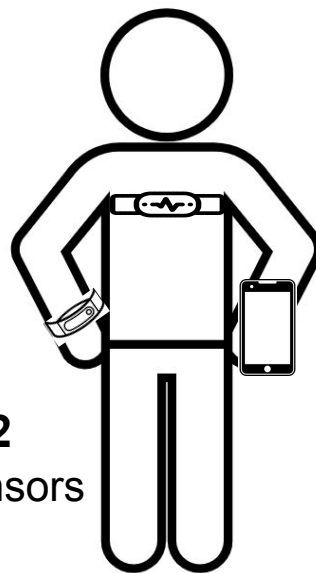
- **#N: 78** (Male:Female=55:23)
- Age: 21.9 (SD=3.8)

### ESM surveys

- Period: 7 days
- **#Sample: 2,227**  
(AVG=28.6, SD=15.9;  
per each participant)



**Microsoft band 2**  
: Physiological sensors



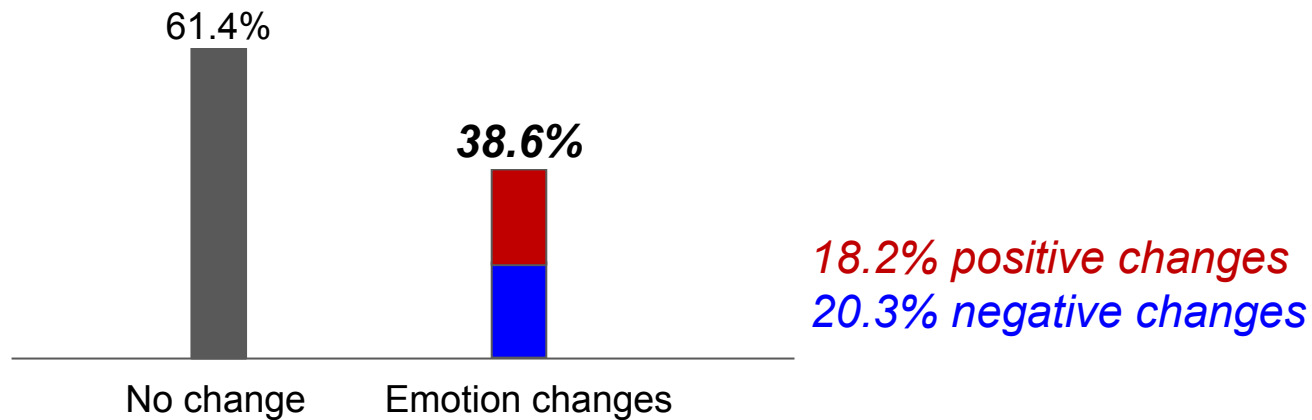
**Polar H10**  
: Heart-rate sensor



**Smartphone**  
: Device usage data  
: ESM surveys



# RQ1) Amount of emotion change



⇒ **Significant portion** of responses can be biased unless people noticed the emotion changes at ESM responses.

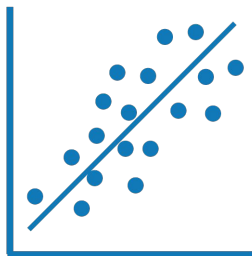
# RQ2) Contextual factors for emotion change (1)

**What factors** affect emotion changes?

extracted from user information, *Microsoft band 2* and *smartphone* sensors.

Data type	Features	Description
Individual information	Age, Gender	Demographics
	Openness, Conscientiousness, Neuroticism, Extraversion, Agreeableness	Personality traits (K-BFI-15)
Subjective contexts	Valence, Arousal, Attention level, Stress level, Task disturbance level	ESM label
Objective contexts	Frequently stayed location (Rank #1, #2, #3)	Whether the participant visited the frequently stayed location in the past one hour
	Phone use time	Recent time spent from the last screen unlock event
	Wrist acceleration (ACC), Skin conductance (GSR), Skin temperature (HST), Heart rate (BPM)	Physiological sensors from MS band 2
	Weekend, Time of day, and their interaction	Meta information of ESM label (Response time)

## RQ2) Contextual factors for emotion change (2)



### Multi-level regression model

8 features were statistically significant.

*Individual-specific factors*

Age  
Gender  
Personality traits (BFI)

$p < 0.05$

*Subjective contextual factors*

Valance (+)  
Arousal  
Attention level (+)  
Stress level (-)  
Task disturbance level (-)

*Objective contextual factors*

Frequently stayed location (#1 (-), #2, #3)  
Phone use time (-)  
Wrist acceleration [mean, stdev]  
EDA [mean, stdev]  
Heart rate [mean, stdev (+)]  
Skin temperature [mean, stdev]  
Response time [Weekend, Time of day, interaction (-)]

# RQ3) Real-life instances of emotion change (1)

Exit-interview with 15 participants; Male:Female = 8:7, Age=23.9 (SD=3.2)

## **Negative** cases



- Interrupt an ongoing task to diminish an individual's attention  
*"I felt a bit annoyed when I received the notification as I was working on my assignment."*

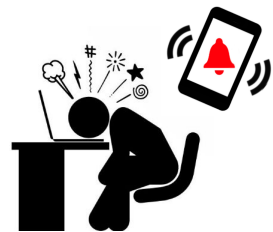


- Violate social norms / etiquette.  
*"I felt sorry to disturb others with the notification vibration in our office."*

## RQ3) Real-life instances of emotion change (2)

Exit-interview with 15 participants; Male:Female = 8:7, Age=23.9 (SD=3.2)

### Positive cases



- Escape from the current uncomfortable (or stressful) situation  
*“When I was stressed, I felt relaxed while I answered the ESM surveys”*



- Lead to a better understanding of users' current emotions  
*“I felt good about winning a computer game, and I felt better when I checked this survey.”*



- Help to recall positive memories in the past  
*“This notification reminds me the moments of yesterday with my girlfriend.”*

# Summary and takeaways (1)

- People can recognize differences in their emotional states before and after the ESM tasks.  
⇒ Clarify the reference time points to be responded (e.g., “right before doing this survey”)
- ESM tasks can change users’ emotions negatively, but positively as well.  
⇒ When interpreting prior ESM studies, researchers should carefully consider possible emotion changes (both positive and negative) in users’ ESM responses

## Summary and takeaways (2)

- Emotion changes are related to several factors including psychological states and contextual information at the time of ESM responses.

*valence, attention level, stress level, disturbance level, frequently visited location, phone use time, heart-rate, and Weekend\*Time of day*

⇒ **Adjusting ESM timing would mitigate changes in emotions** as prior works on interruptibility and opportune moments reported [3, 4], but selective sampling may skew the balance of the emotion distribution.

[3] Pielot et al. (2017) Beyond Interruptibility: Predicting Opportune Moments to Engage Mobile Phone Users. In Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.

[4] Obuchi et al. (2016) Investigating interruptibility at activity breakpoints using smartphone activity recognition API.

Emotion changes during *ESM response tasks* should not be overlooked !

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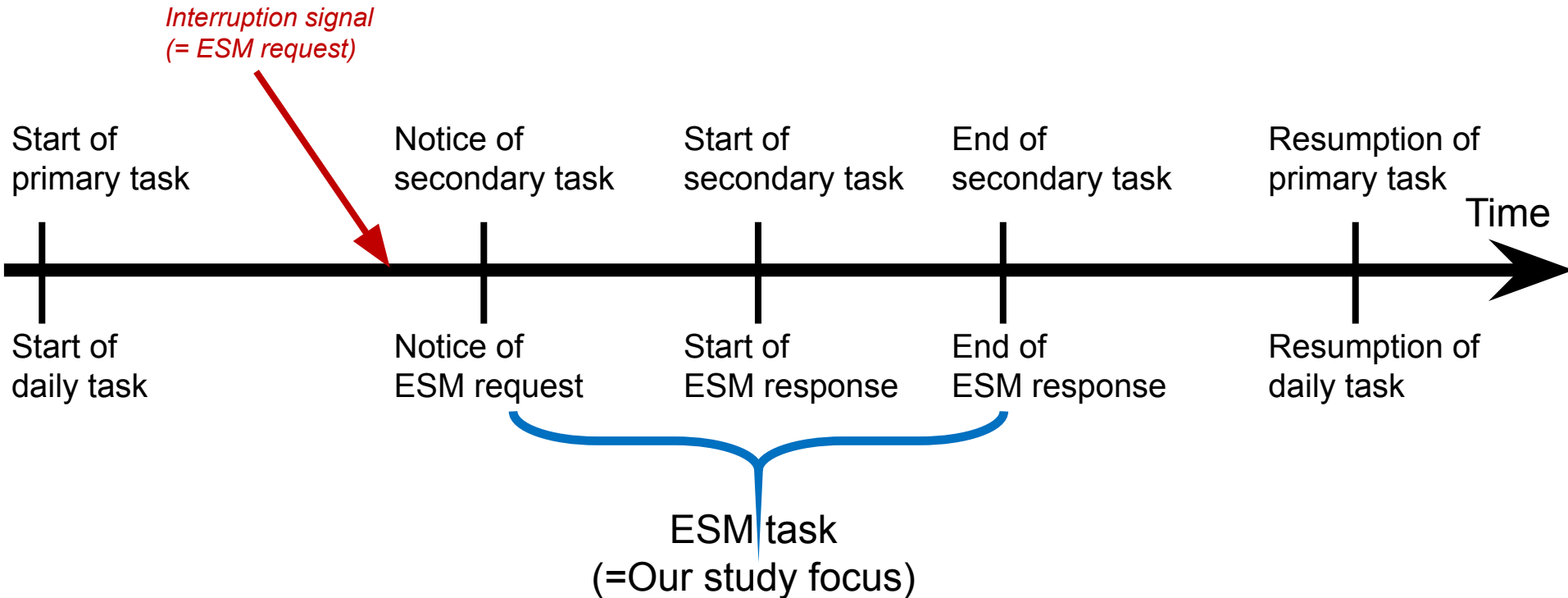
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# Appendix

# Sequential description of the ESM response task



# Data overview



Participants	#N=78, Male:Female=55:23, Age=21.9 (SD=3.8), 7 days of data collection
ESM responses	#Sample=2,227 (AVG=28.6, SD=15.9; per each participant) [ * ] valence, arousal, attention level, stress level, emotion duration, disturbance level, emotion change
Polar H10	Heart-rate (ECG)
Microsoft band 2	Heart-rate (PPG), RR-interval, GSR (EDA), body temperature, accelerometer/gyroscope (IMU), calories burnt, step counts
Smartphone	Location (GPS), Activity tracking (activity recognition, transition time, and stat logging by using Google API), App usage patterns (installed app list, app use time and states), Notification history, Voice call/SMS history, Media usage history, Network connectivity info (cellular or WiFi), Surround wireless device list (WiFi sensing log), Device events (e.g., power on/off and battery usage stat.)

# Guidelines to employ ESM to mobile phones

## Configuration-related points

- control the degree of the interruption during ESM response task.
- manage other sampling protocols (e.g., interval-contingent, voluntary).
- provide different number of survey items.
- consider alternative medium of ESM trigger (e.g., sound, vibration, light)

## Questionnaire-related points

- use proper languages to clarify the questionnaires
- suggest easy-to-understand support words to describe user's status
- study various models to express human emotions