



## Putting mood in context: Using smartphones to examine how people feel in different locations



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### ARTICLE INFO

#### Article history:

Received 6 October 2015

Revised 29 March 2016

Accepted 4 June 2016

Available online 8 June 2016

#### Keywords:

Personality

Big five

Person-situation

Location

Context

Within-person

Mood

Positive affect

Mobile sensing

Multi-level modelling

### ABSTRACT

Does personality predict how people feel in different types of situations? The present research addressed this question using data from several thousand individuals who used a mood tracking smartphone application for several weeks. Results from our analyses indicated that people's momentary affect was linked to their location, and provided preliminary evidence that the relationship between state affect and location might be moderated by personality. The results highlight the importance of looking at person-situation relationships at both the trait- and state-levels and also demonstrate how smartphones can be used to collect person and situation information as people go about their everyday lives.

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### 1. Introduction

We know that personality is linked to behavior. Several studies have shown, for example, that personality is linked to preferences for and success in various occupations (Judge, Higgins, Thoresen, & Barrick, 1999; Lodi-Smith and Roberts, 2007), maintaining satisfying intimate relationships (Ozer & Benet-Martinez, 2006; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007), and how people choose to spend their free time (Mehl, Gosling, & Pennebaker, 2006; Rentfrow, Goldberg, & Zilca, 2011). Our understanding of these links is informed by interactionist theories, which argue that individuals seek out and create environments that satisfy and reinforce their psychological needs. An implication of this argument is that individuals experience higher positive affect and lower negative affect when in their preferred environments. Drawing on past research on person-environment interactions and using experience sampling and mobile sensing technology, the present research investigated whether personality traits moderate the associations between state affect and locations, which are associated with different types of situations.

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Personality is linked not only to behavior, but also to affect. In one study, situational characteristics (social vs. non-social context) and personality traits (Extraversion and Neuroticism) both predicted state positive and negative affect (Pavot, Diener, & Fujita, 1990). People experienced greater positive affect both when they were high in Extraversion, and when they were in social situations, but there was no interaction: people with all levels of Extraversion experienced more positive affect in social situations. In a related study, researchers found that positive affect (but not negative affect) follows a diurnal rhythm, with people socializing, laughing and singing more and more for the first 8–10 h after waking, and then doing those activities less and less (Hasler, Mehl, Bootzin, & Vazire, 2008). Further, this study found preliminary evidence that this diurnal cycle of positive affect may be amplified for people high in Extraversion. These findings have implications for within-person variation in personality, given that affect is assumed to mediate the influence of the situation on personality states (Mischel & Shoda, 1995).

Although there is agreement that features of the environment affect how people think, feel, and behave, there is less agreement on which aspects of the environment have psychological implications (Fleeson & Nofhle, 2008; Rauthmann et al., 2014). The physical environment, including location, is one objective characteristic

often associated with a situation (Rauthmann et al., 2014; Saucier, Bel-Bahar, & Fernandez, 2007). The locations people regularly visit may be consistently associated with a constellation of factors (e.g., affect, sociability, recreation, goal pursuit), and thus represent types of situations that have psychological implications, and clear links to personality. For example, the recently developed DIAMONDS taxonomy identifies several characteristics of situations that might feasibly be linked to locations (Rauthmann et al., 2014); work might be high in Duty and Intellect, and social places, such as restaurants and bars, might be high in Sociality and pOstivity. These situational factors are connected to personality-related behaviors (Rauthmann et al., 2014), suggesting that locations should be as well.

A challenge in studying affect as it is experienced in the various types of situations that people encounter in daily life is the repeated collection of data on mood and situation type. Methodological advances such as experience sampling have made it possible to collect repeated self-reports (e.g., of affect) as people go about their daily lives. However, to date it has been difficult to simultaneously collect objective information about the type of situation in which people find themselves. One exception is a recent paper that used repeated experience sampling to examine the relationship between a person's personality traits, the types of situations they encountered, and state expressions of personality, all of which were self-reported (Sherman, Rauthmann, Brown, Serfass, & Jones, 2015). In this study, state personality (as manifested in behavior and emotions) was independently predicted by both personality traits and situation characteristics.

The advent of mobile sensing technology provides a potential solution to the challenge of collecting repeated information about both behaviors and situations: detect the type of situation using the sensors built-into today's ubiquitous smartphones. These devices come equipped with location sensors, an accelerometer that can detect a user's physical activity, a microphone that can detect ambient noise in the environment, and various other sensors. The potential is great, but little research to date has made use of sensed information to examine psychologically relevant questions.

In the present research, we explored the relationship between state affect and location, which can be thought to represent a type of situation. Our objective was to lay a foundation of preliminary knowledge in the under-explored domain of associations between situation types and state affect.

## 2. Methods

### 2.1. Participants

Participants were members of the general public who downloaded the free app from the Google Play store and installed it on their Android phone. The analyses reported herein include all users who provided data on the measures of interest (described below) from February 2013, when the app was released, to July 2015, when we began the analyses.

A total of 12,310 users provided relevant momentary self-reports of location (i.e., they reported being at home, at work, or in a social type of situation). Of the users who reported demographics ( $N = 10,889$ ), 44% of people who reported their gender were female, 71% of people who reported their ethnicity reported being White, and the most common birth year ranges were 1980–1989 (38%), 1990–1999 (32%) and 1970–1979 (18%).

Given that these users may or may not have provided trait or state self-reports of personality, and may or may not have provided location sensor data (see Section 2.2 for why this is the case), the analyses described in the results section include different subsets

of these users. Ethical clearance has not been granted for sharing the data supporting this publication.

### 2.2. The Emotion Sense application

Emotion Sense is a smartphone application that was designed to study subjective well-being and behavior. The app collects self-report data through surveys presented on the phone via experience sampling. By default, the app sends two notifications at random moments of the day between 8 AM and 10 PM, at least 120 min apart from one another. Clicking on a notification launches a momentary assessment, which includes measures of current affect, and measures assessing a single aspect of current behavior or context (e.g., location, physical activity, social interactions). In addition to the notification-driven surveys, the app also collects self-initiated surveys. These included longer measures of affect, and measures assessing multiple aspects of behavior and context.

As well as collecting self-report data, the app also uses open-sourced software libraries (Lathia, Rachuri, Mascolo & Roussos, 2013) to periodically collect behavioral and contextual data from sensors in the phone. The data collected through the app is stored on the device's file system and then uploaded to a server when the phone is connected to a Wi-Fi hotspot.

Emotion Sense was designed to be a tool to facilitate self-insight, providing feedback about how participants' mood relates to context and activity. In an effort to maintain user engagement over a period of weeks, participants could receive additional feedback by “unlocking” stages, in the same way that players can unlock different levels of a game after achieving certain objectives. Each stage had a particular theme (e.g., location, physical activity) that determined which behavior and context questions (e.g., “Where are you right now?”, “Compared to most days, how physically active have you been today?”) were asked in the self-report surveys. The second stage, related to location, is the only stage reported in these results.<sup>1</sup>

### 2.3. Measures

#### 2.3.1. Trait personality

Users reported their personality on the Ten-Item Personality Inventory (Gosling, Rentfrow, & Swann, 2003). They rated the extent to which ten pairs of words (e.g., “Extraverted, Enthusiastic”) applied to them, on a scale from 1 = *Disagree strongly* to 7 = *Agree strongly*.

#### 2.3.2. Affect

Emotion Sense allows users to track and quantify their psychological well-being in various ways. On each self-report survey, whether notification-driven or self-initiated, users indicate their current feelings by tapping on a two-dimensional affect grid (see Fig. 1), where the x-axis denotes valence, from negative to positive, and the y-axis denotes arousal, from sleepy to alert (Russell, Weiss, & Mendelsohn, 1989).

#### 2.3.3. Location

One way Emotion Sense assesses current location is through place self-reports. Users respond to the question “Where are you right now?”, indicating whether they are at “Home,” “Work,” “Family/Friend's House,” “Restaurant/Café/Pub,” “In transit,” or “Other” (see Fig. 2). We treated both “Family/Friend's House” and “Restaurant/Café/Pub” as social types of situations, and did not

<sup>1</sup> The eighth stage, related to personality, is reported in additional analyses in Appendix 1.

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