Reciprocal interrelations between subjective psychological well-being and passive smartphone indicators of social activity and mobility

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Abstract

Being socially integrated and actively engaged represent central factors related to subjective psychological well-being (SPWB). One way to measure socially related activity and mobility is passive mobile sensing. Based on recent findings, the present study examines Bluetooth and Global Positioning System (GPS) signals as indications of social activity and mobility over a period of six months derived from the longitudinal PhoneStudy data. With the help of a Random Intercept Cross Lagged Panel Model we will investigate reciprocal interrelations between variations in passive social activity and mobility indicators and self-reported SPWB over time, while taking relevant individual (i.e., personality) and situational (i.e. public distancing measures) characteristics into account. Implications for public health research and the promotion of SPWB will be discussed.

Background

Over the past two decades, subjective psychological well-being (SPWB) has gained more attention and prioritization as an indicator of public health, productivity as well as and longevity (i.e., Chiada & Steptoe, 2008; Diener & Chan, 2011). In contrast to a previously common focus on the mere absence of mental illness, SPWB highlights the importance of considering how people think and feel about their lives and offers entry points for the promotion of cognitive and emotional resources that people need to cope with challenging life events (Huppert, 2009; WHO, 2020). Current directions in public mental health research suggest that by promoting SPWB, the incidence of mental illness and suicidality could be diminished (Schotanus-Dijkstra et al., 2016; Huppert, 2009).

As a multi-dimensional construct, SPWB comprises a hedonic (i.e., striving to maximize positive affect and pleasure), eudaimonic (i.e., striving to function well and reach purpose in life) and a social dimension (i.e., striving to contribute to society and be socially integrated; Gallagher et al., 2009). Each dimension has been discussed to contribute to the overall psychological well-being in a unique way (Huta & Ryan, 2010). Furthermore, higher SPWB has been associated with healthy lifestyle while such as being physically active and engaging in social activities (e.g., Cooper et al., 1995; Penedo & Dahn, 2005; Schotanus-Dijkstra et al., 2016). By relating daily

activities with either hedonic or eudaimonoc well-being, Steger and colleagues (2008) identified certain behaviors of personal pleasure (i.e., by buying something for oneself, getting hit on drugs or masturbating) that were more strongly related to hedonic well-being whereas other behaviors of social interaction were more strongly related to eudaimonic well-being (i.e. volunteering, listening to or confiding something personal to another person). While those behaviors relevant for the hedonic dimension showed great short-term benefits, eudaimonic behaviors were most beneficial to create meaningful and satisfying lives with greater overall SPWB in the long-term (Huta & Ryan, 2010; Steger et al., 2008). Up to now, longitudinal evidence on associations between everyday behaviors and different dimensions of well-being is lacking. In conclusion, the present study's first aim is to differentiate between the hedonic and eudaimonic dimension of SPWB in association with certain everyday behavior over time.

Previous research has demonstrated that passive smartphone data can be used to indicate and monitor continuously various everyday behaviors related to health and well-being. Global Positioning System (GPS) signals, for example, have been linked to people's reports of momentary SPWB and research shows that social contexts outside the home or working environment were associated with better well-being (Sandstrom et al., 2017) as was spending time in natural as opposed to urban environments (MacKerron & Muorato, 2013). Moreover, in a recent study, Eskes and colleagues (2016) combined social communication and social exploration derived by GPS and Bluetooth signals to establish a sociability score in order to identify atypical social behavioral profiles. Although prone to error, external Bluetooth signals have been successfully used as a significant proxy for social contact by passively identifying the total amount of signals from other people's smartphones in the surroundings (Eagle & Pentland, 2006).

In sum, previous findings indicate several benefits of sensing passive smartphone data to monitor everyday behavior, such as the avoidance of report bias (i.e., due to varying self-awareness or reflection competencies, recall effects) or the continuous measurement over time allowing for the monitoring of intraindividual variation (Cornet & Holden, 2018). However, current research is fragmentary and awaits further longitudinal evidence based on investigations of relevant behaviors at the same time and their interrelation with various dimensions of SPWB (ibid.). Furthermore, findings regarding interdependency are inconclusive so far and could benefit from analyses on reciprocal interrelation between SPWB and social activity and mobility over time, while taking relevant individual characteristics as moderators into account. Thus, the present study's second aim is to replicate and extend previous findings on associations between behavioral indicators and self-reported SPWB based on passive smartphone data and to examine their reciprocal interrelation over time.

In due consideration of SPWB being sensitive to situational contexts and life events (i.e. Schotanus-Dijkstra et al., 2016), it should also be noted that the current COVID-19 pandemic might have an impact on both psychological well-being and behavior - especially with regard to social activity and free movement. Based on previous experiences, for instance with the SARS or H1N1 pandemic, we can conclude that the separation from loved ones and the loss of freedom and autonomy or enhanced boredom due to measures of isolation and quarantine are

associated with very high psychological costs in the general population (Brooks, 2020; IASC, 2020). Besides acute levels of psychological distress and anxiety during isolation or quarantine, research also suggests long-term burden such as socioeconomic distress (i.e. financial loss, unemployment) as well as behavioral changes such as the continuation of avoidance of crowds and unnecessary social contact (Brooks, 2020). Thus, it is to be assumed that across the study's measurement points we might see changes in SPWB and/or social activity and mobility over time associated with variation in the federal distancing measures. Therefore, the exploration of the role of public distancing measures represents a third aim of the present study.

Hypothesis

We expect reciprocal interrelation of within-person changes in social activity and mobility and psychological well-being over time. More precisely, higher levels of social activity and mobility, as indicated by passive mobile sensing data, are expected to predict higher levels of self-reported SPWB and vice versa.

Method

Data collection

The data will be collected within the research project PhoneStudy, a cooperation project of the ZPID and the LMU Munich. Detailed descriptions about the data collection can be found in the master protocol at [http://dx.doi.org/10.23668/psycharchives.2901]. The present study is an observational study without random assignment to treatment or experimental manipulation. The study design is longitudinal comprising the collection of monthly self-report questionnaires (e.g., SPWB) at 6 measurement points and the continuous sensing of smartphone data.

Survey measures

Based on previous evidence suggesting that investigations of both hedonic and eudaimonic well-being provide more insight into the multifaceted construct of well-being and associated characteristics (i.e., Schotanus-Dijkstra et al., 2016), we intend to measure SPWB by using two scales. As indication of affective well-being, we will use the two-item Happiness Measure (Fordyce, 1988) including an 11-point happiness/unhappiness scale (quality score), and a question asking for the time spent in "happy", "unhappy", and "neutral" moods (quantity score). First, multiplying the quality score with 10, second, adding the quantity score and third, dividing the result by two creates a combined score with higher values indicating better well-being.
As an indication of eudaimonic well-being (covering also aspects of social well-being), we will use Diener et al.'s (2010) Flourishing Scale. The scale is a brief 8-item summary measure of the respondent's subjective evaluation on social relationships, self-respect, purpose, and optimism answered on a 7-point rating scale from 1 (strong disagreement) to 7 (strong agreement). Higher summary scores indicate better well-being.
Based on previous research, the participants' age, sex, educational degree, employment status, subjective health status and personality will be included as covariates and possible moderators in the present analyses (i.e., Schotanus-Dijkstra et al., 2016).

In addition, we will consider the fact that because of the actual COVID-19 related restrictions of public life, the study includes a naturalistic quasi-experimental design with geographically varying level of behavioral restrictions, which will be taken as a control variable and possible moderator into account.

Mobile sensing measures

We will include Bluetooth and GPS signals as operationalization of the level of social activity (e.g., number and duration of active Bluetooth devices in a person's closer vicinity; entropy map visualizing the Bluetooth density of a user's environment) and mobility (e.g., distance covered, number of and average time spent at various locations such as home, work, other social or natural vs. urban environments). Measures will be first aggregated on a daily basis, second averaged for weekdays and for weekends and in a third step averaged on a monthly basis separately for weekdays and weekends.

Analysis Plan

Test of the hypothesis

For testing our hypothesis, we will use a Random Intercept Cross Lagged Panel Model (Hamaker et al., 2015) analyzing reciprocal relationships between trajectories of SPWB and social activity and mobility.

Exploratory analyses (optional)

We expect that certain individual characteristics and personality traits may be related to SPWB and affect relations with the predictors of social activity and mobility. Therefore, we will explore interaction effects between demographic (age, sex, educational degree, employment status) and personality characteristics (openness, conscientiousness, extraversion, agreeableness, neuroticism) as well as the subjective health status with social activity and mobility indicators on the outcome measure SPWB.
Furthermore, we will explore the moderating role of federal distancing measures in response to the COVID-19 pandemic (i.e., public interdiction of premises and movement) for associations between social activity and mobility indicators and SPWB. In this context, we also aim to explore associations between varying levels of public distancing measures in response to the COVID-19 pandemic and SPWB across the German federal states.

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