FULL PAPER

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Smartphonenutzung und subjektives Wohlbefinden: Ein Vergleich
zwischen normaler Nutzung und Verzicht

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Abstract: The study examined the association between smartphone use and subjective well-being by comparing regular use with a deprivation condition. Subjective well-being is defined by cognitive and affective components. Regular smartphone use is studied in various *situations* and for different *functions*. Data were collected in a prolonged qualitative quasi-experimental deprivation study (*n* = 11) using diaries (*n* = 210 diary entries) and follow-up interviews (*n* = 11). Participants kept diaries for 10 days: five days during normal smartphone use and five days during deprivation. Afterwards, we compared well-being during normal use and deprivation. Results show that using the smartphone for infotainment was clearly associated with pleasant emotions, while social interaction apps caused both negative and positive emotions. However, results from the deprivation part of the study indicate that in sum, satisfaction with social relations clearly worsened when not using a smartphone. Moreover, participants had difficulty managing daily life. Taken together, non-usage seems to cause isolation and low subjective well-being.

Keywords: Smartphone use, subjective well-being, emotions, deprivation study, multilevel analysis.

Zusammenfassung: Die vorliegende Studie untersucht den Zusammenhang zwischen Smartphone-Nutzung und subjektivem Wohlbefinden. In einer qualitativen, quasi-experimentellen Verzichtsstudie (*n* = 11) wurde das Wohlbefinden (erhoben durch kognitive und affektive Indikatoren) während regulärer Smartphone-Nutzung sowie während eines Smartphone-Verzichts gemessen und verglichen. Nutzungssituationen und Funktionen operationalisieren die Smartphone-Nutzung, in der Verzichtsphase wurde nach gewünschten Situationen und gewünschten Funktionen gefragt. Smartphone-Nutzende führten während fünf Tagen regulärer Nutzung und weiteren fünf Tagen Verzicht Tagebücher (*n* = 210) und wurden unmittelbar im Anschluss in qualitativen Interviews (*n* = 11) befragt. Die Ergebnisse aus der regulären Nutzungsphase zeigen, dass die Nutzung des Smartphones für Infotainment eindeutig mit angenehmen Emotionen verbunden war, während Apps zur sozialen Interaktion sowohl negative als auch positive Emotionen auslösten. In der Verzichtsphase hingegen verschlechterte sich die Zufriedenheit mit den sozialen Beziehungen insgesamt deutlich. Darüber hinaus hatten die Teilnehmenden Schwierigkeiten, das

tägliche Leben zu bewältigen. Insgesamt führte die Nicht-Nutzung zu verstärkter Isolation und zu einem geringen subjektiven Wohlbefinden.

Schlagwörter: Smartphone, subjektives Wohlbefinden, Emotionen, soziale Beziehungen, Verzichtsstudie, Mehrebenenanalyse

1. Introduction

Being "always on" and "always connected" via a smartphone is a normal state for most people today, at least in developed countries (e.g., Bayer, Campbell, & Ling, 2016). As with other intensively used media, high usage leads to questions about possible consequences and effects. For smartphones, these concerns have especially centered on the connection to subjective well-being. Public discourse mainly points to negative effects, such as cognitive overload or dependency and addiction (Ruhnau, 2016). In addition, the industry itself has already identified such problems and has developed apps aimed at helping people maintain a "controlled digital lifestyle" by disabling the smartphone for a predetermined period of time (e.g., apps called *BreakFree* and *Flipd*). However, the scientific findings about the effects of smartphone use are rather ambiguous (Reinecke & Oliver, 2017). On the one hand, several publications point to negative consequences of heavy smartphone use, such as reduced happiness (Lepp, Barkley, & Karpinski, 2014), the perception of social interactions as "tasks" (Burchell, 2015), or "digital stress" (for an overview, see Hefner & Vorderer, 2017). On the other hand, positive outcomes, such as helping people maintain and expand social contacts and gain social support (Reinecke & Oliver, 2017), sustain social cohesion (Ling, 2012), or recover from strain (Hefner & Vorderer, 2017), have been found.

However, it might be less a question of either/or and more an assessment that smartphones can be simultaneously burdensome and beneficial. In particular, Hefner and Vorderer (2017) argue that the effects might depend on the *specific context* of smartphone use – namely, *how* the smartphone is used and *for what*.

Moreover, today's smartphone use has been found to be more habitual than conscious (Bayer et al., 2016; Oulasvirta, Rattenbury, Ma, & Raita, 2012; Verbrugge, Stevens, & De Marez, 2013). Even while habitual and conscious media use generally can co-occur (LaRose, 2010), Ling (2012) underlines the importance of habits, as smartphone use is so taken for granted that people might become aware of it only when they find themselves *without* a smartphone. Thus, it might be difficult for smartphone users to reflect, for instance, in surveys or interviews, on their daily and habitual smartphone use under normal circumstances. However, studies on media deprivation argue that it is a fruitful way to study normal or habitual behavior under abnormal conditions, such as when people are deprived of regular access to certain media (Kaun & Schwarzenegger, 2014; Mastrolia, 1997; Windahl, Höjerback, & Hedinsson, 1986). Coming from this, we argue that the associations between smartphone use and subjective well-being should become more evident when habits are interrupted or, in other words, when smartphone users are *not allowed to use their smartphones*.

Hence, the present study was aimed at enabling participants to appropriately reflect on their habitual smartphone behavior by using a deprivation condition. Considering the arguments cited above, we agree that smartphone users must be *impeded* from using their phones, as their experiences during a deprivation condition will allow deep insight into the role that smartphones play in their (regular) daily lives. Additionally, to appropriately interpret those deprivation experiences, we argue that we also need a clearer picture of *how* the smartphone is normally used and *for what*. This will allow for taking into account that smartphones might be burdensome and beneficial at the same time.

In the following, we provide a theoretical introduction to subjective well-being and research conducted in the field. We then present the methodology and results of our qualitative quasi-experimental deprivation study, in which smartphone use was observed under normal conditions as well as when participants had to abstain from using their smartphones for five days (experimental condition).

2. Subjective well-being

Subjective well-being can be described as people's evaluations of their lives, including what they consider to be happiness, peace, and fulfillment (Diener, Lucas, & Oishi, 2003). Subjective well-being has two components: "an affective component, which is usually further divided into pleasant and unpleasant affect, and a cognitive component, which is referred to as life satisfaction" (Pavot & Diener, 1993, p. 164).

The affective component of subjective well-being "assesses the amount of pleasant and unpleasant experiences in people's lives" (Schimmack, 2007, p. 96) or "moods and emotions, which […] represent people's on-line evaluations of the events that occur in their lives" (Diener, Suh, Lucas, & Smith, 1999, p. 277). Thus, the overall balance of people's positive and negative emotions contributes to their subjective well-being.

The cognitive component of subjective well-being refers to evaluative beliefs about one's life (Schimmack, 2008). These judgments can be either nonspecific evaluations of a certain time span (e.g., a day, a month, the whole life) or refer to specific and important life domains, such as "cultural life," "leisure time," or "social relations" (Brunnhofer, Platzer, Petrovic, & Rauch, 2010, p. 252). Nonspecific evaluations are known as general life satisfaction or satisfaction with certain life spans. In this study, the focus was on *satisfaction with a day*. Specific evaluations refer to domain satisfaction. In the context of smartphone use, the *social relations domain* is particularly important because one of the core functions of smartphones is to keep in touch with one's social network (Chui, 2014; Lepp et al., 2014). Furthermore, the *social relations domain* is one of the most effectual variables for well-being and satisfaction with life (Trepte & Scharkow, 2017). Therefore, we focus on the social relations domain. This domain includes the evaluation of relationships and communication with family and friends as well as collective activities. General life satisfaction or satisfaction with certain life spans, as well as domain satisfaction, are composed of subjective factors (e.g., evaluation of cultural activities) and objective factors (e.g., frequency of cultural activities).

Emotions are short-term states, while cognitive components are more stable. To some extent, they are interwoven, as emotions are likely to correlate with satisfaction during a particular period. However, at the same time, global satisfaction is likely to diverge from emotions. How satisfied a person is, for example, within the span of a day, is not equal to the sum of all emotional episodes during the day (Diener, 1994).

3. Contexts of smartphone use

As argued above, smartphones can be both a burden and a benefit, depending on the specific context in which they are used (Hefner & Vorderer, 2017). In order to operationalize contexts of smartphone use, we focus on unique characteristics that differentiate the smartphone from other information and communication technologies (ICT). In contrast to traditional mobile phones, people can use multifunctional smartphones similar to a computer. They can access the internet and read the news, play games, or use social media. In comparison to computers, however, smartphones are used in more divers kinds of situations, either as main or side activity, e.g. while standing in an overcrowded bus or waiting for a friend in a café. Thus, building on Gao, Lee, and Zhu's (2014) approach, we differentiate the context of smartphone use concerning (a) applications and (b) situations. We argue that the affective component of subjective well-being will be associated with these contexts of smartphone use. Emotions can be directly associated with discrete situations and/or the use of applications. For the cognitive evaluations, we assume that they are less vulnerable to such single influences. However, the *sum* of different usage settings might also influence the cognitive component.

3.1 Applications as functions of smartphone use

Several approaches to systemize and categorize apps have been suggested (e.g., Anderssohn & Frost, 2013; Blom, Chittaranjan, & Gatica-Perez, 2011). We follow a recent approach by Vorderer, Krömer, and Schneider (2016), who differentiate the use of mobile smart devices by activities and categorize smartphone applications into a small number of general functions. These functions are primarily infotainment (also called "process use" by Elhai, Hall, Levine, & Dvorak, 2017; e.g., games, multimedia, news), support (e.g., navigation, travel, shopping), social interaction (also called "social use" by Elhai et al., 2017; e.g., social media, messaging), and display checking (e.g., seeing if there are new notifications or incoming messages).

Coming from this, we first scrutinize how the use of different functions is associated with our participants' emotions and ask the following:

> *RQ1: How is the use of different smartphone functions associated with pleasant or unpleasant emotions?*

Existing research offers insight into how participants will probably experience the interplay between emotions and functional smartphone use. Using a smartphone for infotainment purposes might relate to pleasant emotions, as smartphone users

perceive such functions positively as a pastime (Oulasvirta et al., 2012). They are used to compensate for negative emotions stemming from daily life disturbances (Elhai et al., 2017). Along with this, Hoffner and Lee (2015) examine the use of mobile phones to regulate negative emotions and find that entertainment and information apps are used for mood regulation. In contrast, display checking can increase people's stress in particular if it interferes with other important tasks (Kushlev & Dunn, 2015).

For interaction apps, the picture is rather diverse. On the one hand, mobile messaging apps "provide users with a communication/coordination tool that is inexpensive, flexible, and easy to use" (Ling & Lai, 2016, p. 17). Users get a feeling of emotional connectedness (Sherman, Michikyan, & Greenfield, 2013) resulting from support and help from others via the smartphone (Trepte & Scharkow, 2017). Further, Vanden Abeele, Wolf, and Ling (2018) describe the use of mobile social media as a "specific kind of sociability" that "support[s] relationship maintenance by enabling individuals to frequently interact with others in ways that re-establish trust in these relationships" (p. 9). On the other hand, evidence has been found that managing (private) social interaction via mobile and online communication is perceived as potential overload and temporal pressure (Burchell, 2015), which is also known as cyber-based overload (Misra & Stokols, 2012) or cognitive overload (LaRose, Connolly, Lee, Li, & Hales, 2014). Finally, to our knowledge, no scientific studies have dealt with smartphone apps, which support daily life.

In sum, existing findings are rather ambiguous. Therefore, we recognized a need to clarify the inconsistent findings of previous research using a deprivation approach.

3.2 Situations of smartphone use

Smartphone use can be integrated in almost every life situation, both as a main or side activity. Thus, its use can hardly be categorized within typical situational dimensions, such as place and time. Furthermore, with regard to anytime, anyplace connectivity, Vanden Abeele et al. (2018) highlight that smartphone use is independent of such constraints (e.g., smartphone users can go shopping before getting up). To study smartphone influence on well-being in *daily life*, we identified four rough daily-life scenarios or stages in which the smartphone can be used and be associated with positive and negative emotions. These are work (e.g., at work, school, or university), leisure (e.g., at home, a café, or a restaurant), travel (e.g., public or private transportation), and social situations (e.g., at friends' or families' place of residence). We ask:

> *RQ2: How is the use of a smartphone in different situations associated with pleasant or unpleasant emotions?*

4. Normal use and deprivation: Changes in subjective well-being

Vorderer et al. (2016) find that the absence of internet access provokes strong emotional responses. Therefore, we assumed that the deprivation of smartphone use would especially influence the affective component of subjective well-being. In addition, in Hoffner, Lee, and Park's (2016) experiment, two thirds of their sample experienced emotions to be negative (e.g., anxious, vulnerable, bored, angry, and sad) during smartphone loss. Consequently, the deprivation of smartphone use could lead mainly to negative emotions. However, and as explained before, smartphone use can cause stress or overload due to a high number of incoming messages (Burchell, 2015; Hefner & Vorderer, 2017; Misra & Stokols, 2012). Therefore, smartphone deprivation could also provoke positive emotions due to a reduced stress level. We argue that the experiences during deprivation can offer insights into the role of smartphones in users' daily lives. As such, predominantly negative emotions during deprivation would indicate the positive role of the smartphone under normal conditions and vice versa. Consequently, we ask:

> RQ3: *What kind of emotions does smartphone deprivation elicit?*

As *general satisfaction with a day* (cognitive component) is more than the sum of all negative and positive emotions during the day, we cannot infer the cognitive component from the emotional experiences. Therefore, we ask:

> RQ4: *What influence does smartphone deprivation have on general satisfaction with a day?*

Concerning satisfaction with social relations, smartphone use is often indicated to exert a positive influence. Ling (2012) shows that mobile phones have become a central device for sustaining social cohesion. In particular, smartphones have been found to have a positive, direct association with peer and family relations (Chui, 2014). Trepte and Scharkow (2017) argue that social media, which are widely used on smartphones, provides multiple ways of communicating and obtaining social support. However, even though social interactions via smartphones might positively influence well-being due to a large number of contact attempts, Rotondi, Stanca, and Tomasuolo (2017) find evidence that the use of smartphones negatively affects the quality of time spent with friends and, consequently, satisfaction with social relations. Those contradictory findings about the role of smartphones for well-being in terms of social relations leads to the final question:

> RQ5: *Are participants less or more satisfied with their social relations during smartphone deprivation?*

5. Method

To tackle our research aims, we performed a qualitative prolonged, quasiexperimental deprivation study with a mixed-methods design. The study was conducted in Germany 2015 and was partitioned into three phases. During the first phase (5 days), the participants' smartphone use was monitored under normal conditions.

During the second phase (5 days), the participants were not allowed to use their smartphones (the deprivation phase). During these first two phases, the performed and impeded smartphone activities, as well as the cognitive and affective components of subjective well-being, were measured daily with a structured diary. With this, we obtained numeric data closely linked to the concrete situations of use and non-use. Immediately after the deprivation phase, we proceeded to the third phase and conducted qualitative interviews with the participants where we asked them to reflect on the previous 10 days.

5.1 Instrument 1: The diary (used in Phases 1 and 2)

During the periods of normal smartphone use and deprivation, a pen-and-paper hybrid feedback and elicitation diary was used. This diary consisted of two questionnaires: a situational questionnaire and a summative daily questionnaire.

The goal of the situational questionnaire was to identify associations between specific situations and functions (context of use) and emotions (affective component). Therefore, participants were asked to report (a) situations in which they used their smartphone (Phase 1) or in which they wanted to use it but were not allowed due to the experiment (Phase 2). Furthermore, for every situation, the participants were asked (b) which applications they used or wanted to use and (c) how they felt when they used their smartphone or when they were forbidden from using it. The diary contained mainly closed-ended questions with 11 options for situations (e.g., at home, in a restaurant), 11 options for applications (e.g., chat application, social networking application), and 16 items for emotions.[1] To select the different discrete emotions, we leaned on the Positive and Negative Affect Schedule (PANAS; Crawford & Henry, 2004). The PANAS is a scale for self-reported measures of effects. It consists of two 10-item mood scales of positive/ pleasant and negative/unpleasant emotions (Schimmack, 2003). To keep the questionnaire simple, we only involved emotions that appeared to be relevant in connection to smartphone use – namely, active, enthusiastic, inspired, happy, relaxed, interested, calm, and entertained (pleasant emotions) as well as nervous, stressed, anxious, annoyed, frustrated, bored, ashamed, and confused (unpleasant emotions). We excluded excited, strong, proud, and alert as well as determined, upset, guilty, and hostile.

Each day of the experiment, the participants were asked to fill out the situational questionnaire at four fixed times, referencing the most recent situation of usage or banned usage. Thus, in total, each participant filled out 40 (4 × 10) situational questionnaires.

The cognitive component of subjective well-being was measured with an additional summative daily questionnaire containing questions on *general satisfaction with the current day* and *domain satisfaction with social relations*. Participants were asked to fill out the daily summative questionnaire at the end of each day. The questionnaire contained mainly closed-ended questions with additional space

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1   The diary and interview guideline are available at http://doi.org/10.5281/zenodo.3685545 (Kohout & Schumann, 2020, February 24).

for comments. *General satisfaction with the current day* and the subjective domain of *satisfaction with social relations* were measured with one item each on a 5-point Likert scale (from 1 = unsatisfied to 5 = satisfied), both adapted from the Personal Well-Being Index (International Wellbeing Group, 2013). The actual items were "If you think about this day, how satisfied have you been with (1) the day in general and (2) your social contacts?" For objective indicators of the quality of social relations, participants were asked about (a) the number of people with whom they had been in contact during the day, (b) the frequency of social activities during leisure time, and (c) with whom they had been in contact. The European Social Survey[2] (2014) and items from Fu (2007) were used for (b) and (c), respectively.

5.2 Instrument 2: The qualitative interview (used in Phase 3)

The qualitative interviews were conducted to ascertain subjective interpretations of the findings obtained from the structured diaries. The observed patterns and striking findings of the personal diaries were used as background information for the interviews, permitting the interviewer to focus on particular aspects of smartphone use and its effects and to discuss them with the participants. Interviews ranged in length from 25 minutes to one hour. The interviews were audio-recorded, transcribed, and analyzed using a predefined hierarchical category system (according to Kuckartz, 2010), which was adjusted inductively during the process of coding the data from the diaries. The deprivation phase was the main point of the discussions. The situations and conditions under which participants felt comfortable or uncomfortable while not allowed to use smartphones were evaluated. Furthermore, we inquired as to whether any changes occurred in their social lives during smartphone deprivation.

5.3 Sampling

The recruitment of participants followed a purposive sampling method introduced by Marshall (1996). Individuals who used their smartphone at least 10 times a day and/or more than 60 minutes a day, and who had owned it for at least one year, were selected because the feeling of deprivation is stronger for those who use their smartphone intensively, thus allowing for better observation of the associations between smartphone use and subjective well-being (Chui, 2014). Lastly, participant variability was ensured in terms of three important variables that were found to influence smartphone use (Initiative 21, 2010): gender, age, and occupation. Finally, we decided to include only persons who had similar predominantly positive levels of general life satisfaction.

To recruit appropriate participants, we announced the study through different media channels (local newspaper and radio) and asked for collaboration. People who were interested in participating in the study (in total 21 persons) were asked

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2   The European Social Survey item is "How often do you meet socially with friends, relatives, or work colleagues?" Answer ranges on a 7-point Likert scale from 1 = never to 7 = every day.

to fill out an online screener questionnaire related to the three aforementioned criteria. For the last criterion, we used Diener's (1993) Satisfaction with Life Scale (SWLS). We selected 11 people who met the criteria to participate in the study. The participants' average age was 24 years (SD = 11.4, min = 14; max = 51). Most participants (8/11) were female. Six different occupations were represented in the sample: pupil (3 participants), student (2), housewife (1), employee (3), self-employed (1), and voluntary worker (1). Figure 1 gives for an overview of the participants' characteristics and fulfillment of our selection criteria.

Figure 1. Demographic breakdown of qualitative interview participants

Intensive smartphone users (= at least 10 times a day and/or more than 60 minutes a day, having used a smartphone for at least one year)			
Overall positive level of general life satisfaction (= measured on Diener's (1993) Satisfaction with Life Scale (SWLS) from 1 (very unsatisfied) to 7 (very satisfied), m = 5.2, SD = 0.8)			
Gender			
Female (8)		Male (3)	
Age			
Under 18 (2)	18–25 (4)	26–45 (4)	Over 45 (1)
Occupation			
Pupil (3)	Student (2)	Employed (3)/ Self-employed (1)	Housewife (1)/ Volunteer (1) (not employed)

F14P	F18S	F18P	F20S	F24H	F27E	F41V	F51E	M16P	M30SE	M31E

Note. The abbreviation is composed of gender (female/male), age, and occupation (P = pupil, S = student, E = employee, SE = self-employed, H = housewife, V = volunteer worker).

We compensated the respondents with €30 for participating in the study. However, the interviews clarified that participants had a high intrinsic motivation and their main motivation to participate in the study was to determine how difficult it would be to dispense with their smartphone.

As the participants knew ahead of time when they would be without a smartphone, they had the opportunity to inform their family members and friends about these circumstances. This allowed for minimizing unwanted negative reactions from their social environments. Additionally, they were allowed to use traditional mobile phones as well as laptops and desktop computers during deprivation.[3]

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3   Due to the participants' high intrinsic motivation to take part in the study, the majority indicated that they did not use "traditional" mobile phones. In total, three participants (two of them parents of young children) accepted the offer to use a compensatory phone for emergencies.

5.4 Analytical strategy

Every participant should have filled out 40 situational questionnaires and 10 summative daily questionnaires. Therefore, we expected a total sample of 440 situational questionnaires and 110 summative daily questionnaires. However, as the participants had to integrate answering the questionnaires in their normal daily lives, they did not always manage to answer the full set of questions every day. Therefore, the following analyses are based on 420 situational questionnaires (210 each in Phases 1 and 2) and 110 summative daily questionnaires (55 each in Phases 1 and 2). The questionnaires collected numeric data, while the qualitative explanations came from the interviews and comments in the diaries. All participants provided commentaries in the diaries, but they differed in frequency and detail (i.e., while some participants described situations in great detail, others just wrote down some catchwords). To interpret such cues, additional information was gathered from the interviews.

To analyze the affective component of subjective well-being, we compared pleasant and unpleasant emotions according to the PANAS. In line with theories on mixed emotions of pleasantness, such as being sad and happy at the same time (for an overview, see Larsen, Hershfield, Stastny, & Hester, 2017; Larsen & McGraw, 2011), our data also showed combinations of pleasant and unpleasant emotions. However, as the theory on subjective well-being does not define how those mixtures associate with subjective well-being, we did not further categorize or analyze them. All answers in which participants stated that they had no specific emotion were labeled as "no emotions."

In total, our sample of 11 subjects completed 530 diary entries during smartphone use and deprivation. Due to the nested structure of the data (several diary entries per participant), we conducted multilevel analyses comprising two levels. Multilevel models recognize the existence of hierarchical data in diary studies (e.g., Schnauber, 2017; Schnauber-Stockmann, Meier, & Reinecke, 2018) to guarantee the independence of cases and avert an underestimation of the influence of person characteristics on the dependent variable (Schnauber, 2017). Even though the number of units at level 2 (person level, 11 subjects) was small, the multilevel analyses produced useful results, as estimations of the parameters in which we were interested (level 1) were not biased, as shown by Maas and Hox (2005). However, Stegmüller (2013) suggests, for small level 2 numbers, only calculating simple models with as few variables as possible and without cross-level interaction, because problems with degrees of freedom might occur. As we were not seeking person differences in our research questions, we decided to only involve predictors at level 1. Multilevel models were estimated separately for each research question. The results showed the appropriateness of multilevel analysis in particular for RQ3 and RQ4 (data obtained from the summative daily questionnaires). However, an ICC of 0.07 for the models answering RQ1 and RQ2 (data obtained from the situational questionnaires) indicated that the influence of level 2 (person level) was relatively low. Nevertheless, as it has been argued that multilevel analysis should be conducted for any ICC different from 0 (for an overview, see Schnauber, 2017, p. 237), we preferred multilevel analysis over a single-level model for RQ1 and RQ2 as well.

6. Results

We present our results in the order of the research questions. We start with findings from the first phase depicting how participants felt under normal conditions, in specific situations, using different functions. Next, we turn to emotions and cognitive components of subjective well-being during deprivation and compare them to the ordinary usage phase. In both cases, we combine numeric insights with qualitative data from the interviews and comments in the diaries. In particular, the qualitative data provide insights into the participants' reflections on the experience and their explanations of emotional states.

6.1 Contexts of normal smartphone use

6.1.1 Functions and emotions

RQ1 asked for the association between the use of different smartphone functions and pleasant and unpleasant emotions. To estimate the association, we conducted a multilevel logistic regression analysis (see Table 1, Model 1).

For this analyses, we used all situational diary entries from the normal usage phase (Phase 1, n = 210 diaries). Emotions were coded as a dummy variable grouping all emotions mentioned according to their pleasantness as 0 = unpleasant or 1 = pleasant. As functions of smartphone use is a nominal scale variable, we defined one function as baseline category ("display checking"), recoded the other functions into categorical variables with two levels (1 = belonging to function, 0 = not belonging to function), and used them as predictors in the regression of the multilevel analysis (Kassambara, 2018). Consequently, estimates of the predictors needed to be interpreted relative to the respective baseline category. As such, the estimates in Table 1 show whether the use of a specific function increases the probability of pleasant emotions in comparison to display checking.

Our results revealed only one significant effect: People were more likely to have pleasant emotions when using infotainment apps on their smartphone (b = 1.39, SE = .67, p < .05). In the diaries, participants explained more concretely what kind of infotainment made them experience positive emotions: M31E was in one situation reading an online newspaper and, in another, he was listening to music on Spotify on his way home and discovered new songs. M30SE experienced positive emotions while watching music television on the "Fritz TV" app while showering. Similar to the findings of Oulasvirta et al. (2012) and Elhai et al. (2017), the statements show that the use of infotainment apps is connected to very different content, and they are used as pastime or compensate daily life situations.

For all other functions, the model shows no significant effects. The interview results revealed that the functions did not exclusively affect emotions; it additionally depended on the *content* of communication. In particular, for the interaction apps, content was shown to be of specific importance for emotional reactions. In the interview, F20S, on the one hand, experienced negative emotions when arguing with her boyfriend via WhatsApp. On the other hand, she reported in her first diary entry in the morning that the messages she received made her feel enthusias-

tic: "I answered and read all messages on WhatsApp and Facebook that were sent to me overnight. They were good messages; therefore, I had these emotions."[4] The role of the content is also highlighted in the following statements: M31E reported to be enthusiastic because he was "planning the weekend with a friend" and F24H reasoned happiness with "tomorrow evening planning: cooking & drinking with friends. I'm very much looking forward to that." Other scenarios for negative emotions associated with social content were reported by F18P, who was annoyed that nobody had answered her messages, and F41V was worried because her child's school had called her to tell her that something was wrong.

Table 1. Multilevel logistic analyses predicting the likelihood of pleasantness of emotionsa for smartphone functions and smartphone usage situations

	Model 1: Pleasantness of emotions[a]: functions[b]		Model 2: Pleasantness of emotions[a]: situations[c]	
	b	SE	b	SE
(Intercept)	.32	.38	1.03	.54
Infotainment	1.39*	.67	-	-
Support	.47	.57	-	-
Interaction	−.02	−.44	-	-
Working	-	-	−.27	.70
Leisure	-	-	−.54	.57
Social	-	-	−.49	.62
Log Likelihood	−108.84		−107.77	
Adjusted ICC	.07		.07	
N_{person}	11		11	
N_{day}	171		166	
R^2 conditional	.13		.10	
R^2 marginal	.07		.01	

Note. Random Intercept Model
[a]Pleasantness of emotions is coded as a dummy variable (1 = pleasant, 0 = unpleasant);
[b]All functions are coded as dummy variables (1 = belonging to function, 0 = not belonging to function), display checking is a reference category; [c]All situations are coded as dummy variables (1 = belonging to situation, 0 = not belonging to situation), travel is a reference category; ***$p < .001$; **$p < .01$; *$p < .05$.

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4   As the study was conducted in German, quotations from the interviews have been translated by the authors.

6.1.2 Situations and emotions

Answering our second research question (*RQ2: How is the use of a smartphone in different situations associated with pleasant and/or unpleasant emotions?*), we developed a multilevel regression model similar to that for the functions (Table 1, Model 2). The likelihood of pleasant emotions for the different smartphone usage situations was estimated using "travel" as the baseline category. Thus, estimates show if smartphone use in a certain situation has a higher probability of provoking pleasant emotions in comparison to a travel situation.

The analysis did not show significant associations. This result indicates that situations of smartphone use are not associated with emotions. As Vanden Abeele et al. (2018) highlight, this might be due to the independence of smartphone use from "real life" situational constraints. That is, what people do on their phone is not connected to their physical situation. However, our interviews suggested that, in reality, the interplay between situations of smartphone use and emotions might be more complex. It appears to depend on a specific combination of situation, function, content, and the question of whether the usage episode is self- or other-directed. Positive emotions were reported in situations where specific functions helped participants manage their daily lives and where they initialized the smartphone use themselves. For example, in work-related situations, positive emotions were frequently linked to supportive apps, which helped participants undertake tasks, such as "using Google Maps on the way to a conference" (F24H) or "as help to fall asleep" (F20S). Negative emotions were reported in situations where the smartphone played a disturbing role. In particular, the pairing of social interaction apps with other-directed communication was mentioned multiple times as a cause of unpleasant emotions in the interviews. For example, F18P said that she had received funny pictures while doing homework. She judged this situation as inappropriate for receiving entertaining material. Moreover, working, shopping, and relaxing were mentioned as situations when other-directed communication was perceived as annoying, in particular when the content of the messages was regarded as unimportant. Interestingly, participants reported that they felt unable to control or manage such situations, for example, by putting the smartphone away. In his interview, participant M30SE stated the following:

> This temptation... You are doing your thing and the smartphone is right next to you and you think, "Has it just blinked? Has is just blinked or was it only a reflection?" But this is obviously happening every 10 to 20 minutes. It is really annoying.

In addition, several participants indicated the experience of social pressure to answer a message immediately as a reason for the perceived annoyance. In her interview, F41V described a situation of smartphone use while learning and argued, "These are those moments when I just really want to be undisturbed because, when a message comes in, I feel compelled to read and answer it immediately." Participants even reported a fear of social punishment (e.g., complaints) if they did not answer a message immediately. In the interviews, one participant (F18P) described how one of her friends reacted to a delayed response: "I saw

you online last time, and you didn't answer straight away." She claimed that this was annoying.

To sum up, we found that using the smartphone for infotainment purposes is associated with pleasant emotions and, thus, contributes positively to subjective well-being. Apart from that, our results suggest that whether smartphone use is associated with pleasant or unpleasant emotions depends on specific combinations of situation, function, content, and other- or self-directed usage episodes. This especially holds true for usage episodes with social interaction apps. In the case of positively perceived content received in appropriate situations, interaction apps can trigger pleasant emotions. In the case of negatively perceived content received in inadequate situations, smartphones are perceived as a burden.

6.2 Smartphone deprivation: Effects on subjective well-being

6.2.1 Smartphone deprivation and emotions

In RQ3, we asked what emotions smartphone deprivation elicits. With the data from the situational questionnaires in the deprivation phase (Phase 2, *n* = 210), we developed an unconditional multilevel logistic regression model (null model). With the analysis, we strived to only predict the likelihood of experiencing pleasant emotions during smartphone deprivation (1 = deprivation, 0 = usage). Therefore, we did not involve further predictors and only conducted an unconditional model (null model).

The results of the null model revealed significant evidence that the likelihood of experiencing negative emotions (0 = unpleasant, 1 = pleasant) increased in the deprivation phase (*b* = –2.17, *SE* = .80, *p* < .01; *ICC* = .576, log likelihood = –60.31, *R*² conditional = .57, *R*² marginal = 00). It must be noted that the participants were asked how they felt when they wanted to use their smartphone but were not allowed to do so. This might be an explanation for the predominance of reported negative experiences in the quantitative data. Positive experiences could be underestimated. However, our results from the qualitative interviews, in which we asked for positive experiences as well, underline that the negative experiences indeed outranged the positive ones. This is particularly noticeable in respect to the importance of smartphones in users' daily lives. Participants highlighted the difficulty of living without a smartphone. Participant F27E felt "unable to do online shopping, banking, google information, boil eggs, and take pictures." Further, participant F41V underlined that she was astonished how hard it was for her to live without a smartphone:

> As I said, I thought that I would handle it [the deprivation] easily. Nevertheless, I have my daily routines, my habits – and this was something I missed. I even felt annoyed: I want that now [to use the smartphone], but I cannot.

We can conclude for RQ3 that mainly due to the experience that daily life is more difficult, smartphone deprivation is associated with negative emotions. Our results point to the high importance of smartphones for managing daily life.

6.2.2 Smartphone use and satisfaction with a day and with social contacts

Finally, in RQ4 and RQ5, we were interested in the influence of deprivation on satisfaction with a day and with social contacts. The data from all daily questionnaires of both phases (*n* = 110) were used for separate multilevel regression analyses. We first turn to the results for the subjective measures of day satisfaction and satisfaction with social contacts (see Table 2). Then we present the results for the objective measures of satisfaction with social contacts (see Table 3).

Beginning with the subjective measures, the findings show that the influence of smartphone deprivation on general satisfaction with a day (RQ4) was not statistically significant between usage and deprivation (see Table 2, Model 1).

Concerning the subjective evaluation of the important domain of *social relations* (RQ5: *Are participants less satisfied or more satisfied with their social relations during smartphone deprivation?*), we observed a statistically significant main effect (*b* = –.52, *SE* = .16, *p* < .01). Thus, while smartphone usage seems not to be associated with satisfaction with the whole day, it is associated with satisfaction with social relations. This effect remained even when we controlled for the objective measurements of satisfaction with social contacts – namely, the number of regular and irregular meetings as well as the number of people in contact with during a day (see Table 2, Model 2). Considering controls, the multilevel analysis results show the significance impact of all three objective factors of social relations. While deprivation itself has a negative influence on satisfaction with social contacts, the objective factors of social relations are all positively associated with social contact satisfaction.

With additional multilevel (logistic) analyses, we also tested whether the objective measures changed between the phases (see Table 3). We found no significant differences between the number of people with whom participants were in contact during normal use and deprivation (Table 3, Model 1) and no influence on the number of regular meetings, such as weekly recurrent appointments (Table 3, Model 2). However, our results show that during smartphone deprivation, the likelihood of irregular meetings sank significantly (Table 3, Model 3).

The interviews gave insights that might explain these results. Participants explicated that most of their smartphone contacts were colleagues, friends, or classmates with whom they meet anyway, with or without a smartphone. Thus, the number of contacted persons remained almost unchanged. What changed (according to F24H) was the frequency of being in contact with those persons, which was lower without the smartphone. Furthermore, F18S explained in the interview that "With my mom, I normally have phone calls and we chat on WhatsApp. Now, we had to write emails."

On some occasions, participants experienced the reduced frequency of communication as pleasant, because they were disturbed less by messages/contact attempts. They perceived a large number of incoming messages as stressful or annoying. As mentioned earlier, this happened in particular when messages containing unimportant information interrupted their activities or when a message required an immediate answer. In her interview, participant F20S stated, "Otherwise, it is surely annoying because you permanently get contacted even

because of the tiniest shit." However, the reduced number of incoming messages and contact attempts did not lead to higher satisfaction with the day.

Table 2. Multilevel analyses predicting satisfaction with the day and social contacts from deprivation

	Model 1: Satisfaction with a day [b]		Model 2: Satisfaction with social relations[b]	
	b	SE	b	SE
(Intercept)	.55	1.64	3.34***	.25
Deprivation [a]	−1.10	1.43	−.52** [e]	.16
Irregular meetings[c]	-	-	.72***	.19
Regular meetings[c]	-	-	.56*	.29
Number of people in contact with during a day[d]	-	-	.05***	.01
Log Likelihood	−382.07		−140.83	
Adjusted ICC	.247		.244	
N_{Person}	11		11	
N_{day}	110		108	
R^2 conditional	.25		.49	
R^2 marginal	.00		.24	

Note. Random Intercept Model
[a] Deprivation is coded as a dummy variable (1 = deprivation, 0 = normal usage); [b]Satisfaction with day/Social contacts is coded on a 5-point Likert scale (from 1 = unsatisfied to 5 = satisfied); [c]Irregular/Regular meetings are coded as a dummy variable (1 = had meeting, 0 = had no meeting); [d]Number of people in contact with during a day is a metric variable ranging from 1 to 40 (SD = 11.02); [e]Main effect of deprivation in Model 2 is $b = −.52***$, $SE = .16$; ***$p < .001$; **$p < .01$; *$p < .05$.

Participants also observed a change in the quality of communication and evaluated it as positive. Small talk with contacts decreased (M31E). On remaining communication activities, participants spent more time, and it was more intense:

> *I instead met my friends, or they visited me just because they knew they couldn't text me. Otherwise, we only would have been chatting with each other. But that my friends actually came over, and we really were just talking for an hour, that was very great. (F27E, interview)*

All of these results from the interviews seem to contradict our finding from the multilevel analysis that people were subjectively less satisfied with their social relations during deprivation. However, in the interviews, participants also under-

lined that less communication caused by smartphone deprivation was not only experienced as positive but also provoked a feeling of isolation. This was especially the case when close friends were contacted less frequently. In the interview, participant F51E stated that "I contacted them in those five days only once by landline or face to face. Normally, in the evening, I write a quick WhatsApp text or something like that." In addition, F18S said in her interview, "Suddenly, there had been silence between him and me for four days. That definitely bothered me." This became especially problematic when social contacts lived in different places. F20S stated in the interview that contacting her mother became quite difficult without a smartphone. She reported that they always missed each other when trying to use other online channels for communication that required them to be online at the same time (other than WhatsApp).

Table 3. Multilevel (logistic) analyses predicting changes in objective factors due to deprivation (Random Intercept Models)

	Model 1: Number of people in contact with during a day [a]		Model 2: Regular meetings [b]		Model 3: Irregular meetings [b]	
	b	SE	b	SE	b	SE
(Intercept)	12.22***	1.86	−2.99***	.90	−.06	.45
Deprivation[c]	−2.04	1.36	.67	.96	−1.14*	.49
Log Likelihood	−34.32		−34.32		−65.62	
Adjusted ICC	.511		.248		.262	
N_{person}	11		11		11	
N_{day}	108		110		110	
R^2 conditional	.57		.28		.35	
R^2 marginal	.02		.03		.07	

Note. Random Intercept Model
[a]Number of people in contact with during a day is a metric variable ranging from 1 to 40; [b]
[c]Irregular/Regular meetings are coded as a dummy variable (1 = had meeting, 0 = had no meeting);
[c]Deprivation is coded as a dummy variable (1 = deprivation, 0 = normal usage); ***$p < .001$; **$p < .01$; *$p < .05$.

Surprisingly, the problem of being isolated from social relations not only occurred for those contacts living in different geographical places but also for people living in the same place. In our objective measures, we observed a significant difference of the frequency of irregular social meetings between normal usage and deprivation (Table 3, Model 3). When using the smartphone, participants met others more often spontaneously than without the smartphone. As already addressed, participants explained in the interviews that spontaneous meetings were impossible to arrange without a smartphone:

> It is not easy to arrange a spontaneous meeting. You have to turn your computer on first or walk over and/or ring the bell […]. I once walked over

and rang the bell, but she was unavailable at that moment. (F18P, interview)

We assume that this feeling of isolation finally outweighed the positive experiences during deprivation and that this is the reason why participants subjectively were less satisfied with their social relations during deprivation. Taken together, for RQ5, we conclude that in sum, the participants were less satisfied with their social relations during deprivation due to less frequent contact with friends and family, both digitally and face to face.

7. Discussion

Existing research on the influence of smartphone use on subjective well-being shows contradictory results. We argued that our differentiation of contexts of smartphone use as well as the experiences during deprivation might provide deeper insight.

Considering the ordinary usage phase, our results show that using the smartphone for infotainment was associated with pleasant emotions. Apart from that, positive or negative emotions resulted from specific combinations of function, situation, content, and who initiated the usage episode: the user or his/her contacts. In particular, for self-directed usage, the qualitative part of our study showed that participants adopted their smartphones as "assistants" that helped them manage daily life from morning to evening and along with this, subjective well-being was influenced positively. In line with this, the emotions during deprivation were rather unpleasant. As our participants predominantly had high intrinsic motivation to participate in the study, we assume that the negative experience during deprivation could be even worse for people who are less or not willing to abstain from using their smartphone. In the interviews, participants explained that it was difficult for them to live without the smartphone and, without having been deprived of it, they never had expected that living without a smartphone would be so difficult. The concept of micro-coordination 2.0 already pointed to the importance of messaging apps for managing daily life and social cohesion via interpersonal communication (Ling & Lai, 2016). Our results indicate an even more important function of the smartphone: With its multifunctional character, which is not limited to messaging apps, it not only sustains and organizes social cohesion but helps in sustaining and organizing almost all facets of daily life in general.

Apart from this positive picture, the association between the use of interaction apps and subjective well-being requires further consideration. Again, the qualitative results show that it is the interplay between situation, function, content, and directedness of the communication that leads to negative (or positive) emotions (see also Hefner & Vorderer, 2017). Participants explained that they appreciated being contacted with "good messages" but felt bothered by their smartphone in other-directed communication about unimportant or needless reasons and in unsuitable situations.

It remains unclear why participants failed to control the amount of other-directed communication in unsuitable situations with coping strategies, as they have evolved for other ICT, such as instant messaging on the computer or the traditional mobile phone (Baron, 2008). In other words, why did they not activate flight mode or even switch off their smartphone? Theoretically, we might surmise about two possible explications. First, Clayton, Leshner, and Almond (2015) explain the inability to stay away from the phone with the *extended self theory*. The theory proposes that an individual's possessions (e.g., smartphones) "can become an extension of one's self" (p. 3). In an experiment, the researchers observed increasing heart rate, blood pressure, and feelings of anxiety as well as decreased self-reported extended self when participants were separated from their phone. Theoretically, it could be argued that users try to avoid such feelings, which would reduce their ability to stay away from the phone.

Second, the answers obtained in the interviews point to perceived social pressure from friends and acquaintances. This might be a manifestation of what Bayer et al. (2016) call the *societal rule for connectedness*. Today, most people assume that they must be available for others on a regular basis, as they are enmeshed in a social network wherein the smartphone has become the central device for organizing social connections. Bayer et al. (2016) call this societal expectation of accessibility the connection norm. On the one hand, participants might have feared violating the expectations of their social networks when answering messages after a delay, leading to a feeling of discomfort when they were not constantly checking the display – even in unsuitable situations. We assume that this connection norm is likely most prevalent for smartphone users who have a strong "need to belong" and/or a "fear of ostracism" (Mai, Freudenthaler, Schneider, & Vorderer, 2015). However, people tend to perceive a greater obligation to answer immediately than they expect of others (Mai et al., 2015). Thus, the social pressure that participants feel to be available all the time might be initiated more by themselves than by others. On the other hand, within huge social networks, there are indeed also close ties (e.g., partners, family members, or close friends) for which participants want to remain accessible. Thus, they allow themselves to be disturbed and bothered because being unavailable could lead to missing a personally important message.

These results obtained from the ordinary usage phase might convey the impression that the role of smartphone use for satisfaction with social relations is rather double-sided. However, when it comes to deprivation, the results clearly indicate that in sum, being deprived of one's smartphone is more disturbing for satisfaction with social relations than being unable to "adjust the volume" (Baron, 2008) of communication requests and, consequently, "suffering" from annoying and burdening usage episodes. Most prominently, satisfaction with social relations clearly worsens during deprivation. Even if participants were in contact with a similar number of the same people (close friends and family members) through their regular meetings and reported positive aspects of deprivation (e.g., having more talks of higher quality), they felt socially isolated.

It seems that smartphones allow people to be and feel constantly connected, independent of time and space – a concept that has been called "connected pres-

ence" (Licoppe, 2004). Deprivation prevents people from being constantly connected and it appears that not being part of the normal communication flow in a social network evokes feelings of isolation. This is not just a subjective feeling; our data show that participants indeed had a lower likelihood of meeting people spontaneously during the deprivation phase. Taken together, these findings clearly support the so-called stimulation hypothesis, which argues that new technologies can reduce loneliness if they are used, for example, to enhance existing relationships (for an overview, see Nowland, Necka, & Cacioppo, 2018). Moreover, these findings show the high value of the deprivation design. The outcome that being unable to use a smartphone leads to a feeling of social isolation and is associated with fewer spontaneous meetings became particularly clear with our deprivation study design. In addition, the importance of the smartphone for managing daily life successfully would not have become so obvious without the deprivation approach.

8. Limitations and future research directions

Although our data shed light on the complex associations between smartphone use and subjective well-being, our approach can be improved and extended. For example, as the sample was small, we would recommend replicating this study with a larger sample. For this, we propose a sampling strategy that does not exclusively focus on intensive users but considers other user variables as well. Concerning usage intensity, we argue for additionally focusing on light or heavy smartphone users. Perhaps light users protect themselves against annoying smartphone communication and have developed coping strategies, while heavy users might have more negative experiences. With regard to our results on interaction apps, we also propose considering different usage patterns. For example, studies on the associations between social internet use and loneliness show that feelings of loneliness either increase or decrease depending on how recipients use social technologies (Nowland et al., 2018). Our results indicate that all participants used their smartphone to stimulate existing (offline) relationships, which probably explains why some of them felt lonely during deprivation. This result might be even stronger for users who have displaced offline interactions with online activities (Nowland et al., 2018). In sum, a comparison of different user groups might reveal whether some users profit from the positive effects of smartphone use on subjective well-being without suffering from the negative ones or experiencing many more negative effects in daily life.

In addition, future work can improve our study by extending it as follows: First, future studies can more explicitly concentrate on measuring emotional states in situations that smartphone users normally judge as inappropriate but in which they are not disturbed during deprivation. In our study, during deprivation, participants wrote in their diary only in situations when they wanted to use their smartphone. Situations where they were not disturbed during the deprivation phase were only reflected in the qualitative interviews and in the assessment of day satisfaction. Thus, we suggest that future work also strive to scrutinize such situations in the diary as well. Presumably, the experience of smartphone depriva-

tion as a "bittersweet situation" (Larsen et al., 2017; Larsen & McGraw, 2011; Larsen, McGraw, & Cacioppo, 2001) would become more obvious and its associations to subjective well-being could be studied in a more nuanced way.

Second, while our qualitative results show that our empirical design generally measured emotional states as consequences of smartphone use, we got a few hints regarding reversed causality in some situations. Via conscious manipulation of situations and functions of smartphone use, emotions might be induced in an experimental setting, which will allow for investigating the causality of the correlation.

Third, we suggest extending our approach to contexts of smartphone use by considering combinations of situation, function, directedness of the usage episode, content of incoming messages, and relation to the sender of a message (strong or weak tie).

Fourth, our data offer a few hints that some participants started to change their smartphone habits after deprivation. For example, F18P said that after deprivation, she left the smartphone in her schoolbag instead of having it in her pocket. Similarly, Kaun and Schwarzenegger (2014) found hints of changed behavior in their study on internet absence. Future studies could explicitly focus on the question of how and why some users change their habits, how stable and lasting these changes are, and if they help in (better) maintaining a controlled digital life.

Finally, it might be of interest to scrutinize whether the perceived social pressure that leads to constantly checking smartphones and answering requests instantly is an objective and "real" phenomenon or whether it is a subjective fear that friends and acquaintances might be upset about a delayed response.

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