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When do smartphones displace face-to-face interactions and what to do about it?

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ABSTRACT

There is a public concern that smartphone communication undermines well-being by displacing face-to-face interactions. However, research on this "social displacement hypothesis" has provided mixed results. We examined when this hypothesis holds true (within-persons vs. between-persons) and tested an intervention to decrease smartphone communication. Participants (N = 109) reported daily on smartphone communication, face-to-face communication, and emotional well-being for fifteen days. At day six, participants were assigned to a mindfulness-treatment intervention group or a no-treatment control group. The social displacement hypothesis was confirmed at the within-person but not between-person level. Specifically, when someone communicates a lot using her smartphone during a particular day, that person engages in less face-to-face interactions during that same day. However, people who tend to spend a lot of time communicating on their smartphone do not engage in less face-to-face conversations than people who largely refrain from smartphone communication. The mindfulness-intervention reduced daily smartphone communication, which decreased negative emotions.

1. Introduction

More than two billion people possess a smartphone (Takahashi, 2018) and spend on average 3 h on their mobile devices each day (Comscore, 2017; Ofcom, 2018). A significant portion of that time is spent communicating with others by calling, messaging or connecting on social network sites such as Facebook or Instagram (i.e., smartphone communication). Smartphones offer benefits in many domains including healthcare (Camacho et al., 2014), safety (White, Thompson, Turner, Dougherty, & Schmidt, 2011), and education (Godwin-Jones, 2011) but there is a growing public concern that smartphone communication may displace the time we spend interacting with others face-to-face (Kushlev, Dwyer, & Dunn, 2019; Sbarra, Briskin, & Slatcher, 2019). This concern is strengthened by research showing that interacting face-to-face is vital for well-being (Kross et al., 2013; Myers, 2000).

But does smartphone communication actually result in a decline in face-to-face interactions? This question is severely debated as reflected by two opposing viewpoints (Ahn & Shin, 2013; Dienlin, Masur, & Trepte, 2017). According to the social displacement hypothesis, time spent interacting on smartphones replaces face-to-face interactions. However, according to the social augmentation hypothesis, smartphone communication does not result in a decline in face-to-face interactions and may even foster them. The rise of a number of other technologies (e.g., television or internet) has led to similar debates (Kraut et al., 1998; Putnam, 1995) but smartphones added an entirely new chapter to research on social displacement due to their massive adoption, permanent accessibility, and unprecedented communication potential. Resolving the social displacement versus augmentation debate in the context of smartphone communication is critical, not only from a theoretical but also from an applied perspective as practical recommendations on healthy smartphone usage differ dramatically between these two viewpoints.

Here we suggest that the solution to this debate may be situated at the level of analysis: within-persons vs. between-persons. At the within-persons level, one may expect a negative relationship between both communication modes. A person engaging a lot (i.e., more than she typically does) in smartphone communication during a particular period of time (e.g., a day), is likely to engage less in face-to-face interactions during that same period, as time invested in one type of communication is no longer available for other types of communication. At the between-persons level, however, one may expect a non-significant or even positive relationship between both communication modes. Avid smartphone

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users may communicate overall more than people who largely refrain from smartphone communication, as suggested by research showing a positive relationship between extraversion and smartphone use (Montag et al., 2014). This would imply that people who tend to engage in smartphone communication a lot (i.e., more than other people typically do), do not engage in less face-to-face interactions than other people do. In fact, they may even engage in more face-to-face interactions, which would be reflected by a positive relationship between both communication modes between-persons.

Categorizing prior research on the social displacement (versus augmentation) hypothesis in the context of smartphone communication suggests that the relationship between face-to-face communication and smartphone communication may indeed be different depending on the level of analysis. The social displacement hypothesis has most often been studied using cross-sectional designs, which allow for claims at the between-persons level of analysis. These studies typically disconfirmed the social displacement hypothesis revealing no negative relationship between face-to-face interactions and smartphone communication (Cho, 2015; Pollet, Roberts, & Dunbar, 2011). In fact, a number of cross-sectional studies support the social augmentation hypothesis; they indicate that face-to-face communication is positively related to smartphone communication (Ahn & Shin, 2013; Charoensukmongkol, 2018; Kim, 2017), or social media use, which is a popular subtype of smartphone communication (Lima, Marques, Muiños, & Camilo, 2017; Twenge, Spitzberg, & Campbell, 2019).

Longitudinal studies similarly reject the social displacement hypothesis (Dienlin et al., 2017; Lapierre, Zhao, & Custer, 2019). However, in these studies smartphone and face-to-face communication were only assessed across a limited number of two waves. Such designs allow examining concurrent and lagged between-persons relationship but do not allow for within-persons relationship as this requires *intensive* longitudinal data (e.g., diary or experience sampling designs; (Bolger & Laurenceau, 2013). Such studies on the social displacement hypothesis in the context of smartphone communication are rare. However, three exceptions should be noted where the within-persons relationship between face-to-face communication and one popular mode of smartphone communication was examined, namely social media.

Using an experience sampling design, Hall and colleagues (Hall, Kearney, & Xing, 2018) asked participants five times per day for a period of five days whether they had social interactions with anyone in the last 10 min, and, if so, through which medium. They found that social media use at prior times of day was not associated with future face-to-face interactions at the within-person level. However, both face-to-face interaction and social media use was assessed using a discrete measurement approach (engaged in a particular communication mode: yes vs. no). As such, this study does not allow making conclusions on the relationship between the amount of time spent on social media and the amount of time spent interacting with others face-to-face, as this requires a continuous measurement approach.

Kross and colleagues (Kross et al., 2013) and Verduyn and colleagues (Verduyn et al., 2015) also conducted an experience sampling study and found a negative concurrent relationship between Facebook use and direct interaction at the within-persons level. However, in both studies direct interaction referred to face-to-face communication and talking on the phone preventing a more direct test of the social displacement hypothesis. As such, while previous cross-sectional research on the social displacement hypothesis suggests that this hypothesis does not hold at the between-persons level of analysis, a number of experience sampling studies indicate that smartphone and face-to-face communication may be negatively associated within-persons.

The first goal of this study was to directly test and contrast the relationship between the quantity of smartphone communication and quantity of face-to-face interactions within-persons versus between-persons. Even though smartphones can also be used for non-social purposes, we focused on social smartphone use (i.e., smartphone communication) as this usage type is conceptually closest to face-to-face communication. In addition to smartphone communication in general, we also examined use of social network sites on smartphones as this particular subcategory of smartphone communication has fueled the public debate on social displacement in today's society (Twenge et al., 2019).

Our second aim was to test a theory-guided intervention that may protect people from the negative emotional consequences associated with the social displacement hypothesis by decreasing the amount of time people spend communicating on their smartphones while stimulating face-to-face interactions. One's immediate environment typically provides plenty of opportunities for face-to-face interactions. Typical examples include having a face-to-face conversation with a fellow-passenger on the bus or train, with one's partner when arriving home from work, or with a colleague while waiting for the next meeting to start. However, in each of these examples, one may instead decide to focus attention away from one's immediate environment by using one's smartphone to engage in a digital conversation with a remote other instead. Several motives underlie people's use of smartphones (Jung, 2014), but one key reason for smartphone use is distraction (Levine, Waite, & Bowman, 2012) with smartphones offering their users an endless number of possibilities to disengage from (the people in) their immediate surroundings (Sbarra et al., 2019). This distracting potential of smartphones may not only prevent people to initiate a face-to-face interaction but may also accelerate termination of an ongoing face-to-face conversation. As such, one approach that may lower people's use of smartphones (while stimulating face-to-face interactions) is increasing their motivation to sustain attention on their present surroundings and associated potential for face-to-face interaction.

A well-known method to increase people's focus on the present is mindfulness training. Mindfulness refers to a state of consciousness in which individuals pay attention to present-moment experiences (Brown & Ryan, 2003) and has been shown to be positively related to a wide range of well-being indicators (Creswell & Lindsay, 2014). In this vein, correlational evidence has established a negative link between mindfulness and excessive use of smartphones (Elhai, Levine, O'Brien, & Armour, 2018; Kircaburun, Griffiths, & Billieux, 2019). However, to our knowledge, no experimental research has examined whether enhancing mindfulness (vs. control condition) causally impacts smartphone communication (for two small scale pilot studies, see Trub & Starks, 2017; Yukun et al., 2018). Thus, our second goal was to examine whether a mindfulness intervention decreases (increases) the amount of time people spend daily communicating on their smartphone (face-to--face) and whether this, in turn, increases emotional well-being.

We pursued these goals by randomly assigning 121 participants to one of two groups in a field experiment: a mindfulness-treatment intervention group and a no-treatment control group. For fifteen consecutive days, participants reported daily on their level of smartphone communication, face-to-face communication, and emotional well-being (positive and negative affect). On day six, a mindfulness intervention was implemented creating a baseline (day 1–5) and intervention study phase (day 6–15). This design allowed us to examine whether the relationship between smartphone communication and face-to-face interaction varies as a function of whether data is analyzed at the within- or between-persons level. Moreover, our study allows examining whether a mindfulness intervention reduces (increases) smartphone (face-to-face) communication and whether this change, in turn, impacts subjective well-being.

Subjective well-being consists of two components: (a) high levels of positive affect and low levels of negative affect (i.e., affective component), and (b) high levels of life satisfaction (i.e., cognitive component) (Diener, 1984). A high level of subjective well-being is one of the most important goals people strive for in life (Diener, Sapyta, & Suh, 1998) and predicts people's health (Boehm, Peterson, Kivimaki, & Kubzansky, 2011), income (Diener, Nickerson, Lucas, & Sandvik, 2002) and success (Lyubomirsky, King, & Diener, 2005). In our study, we focused on the affective component of subjective well-being (referred to as emotional

well-being) as it is more dynamic across short timespans than its cognitive counterpart, making it optimally suited for a diary study (see Fig. 1).

2. Method

2.1. Ethics statement

The study was granted ethical approval by the Ethical Review Committee of Psychology and Neuroscience (ERCPN) at Maastricht University. Participants provided informed consent.

2.2. Participants

Participants were volunteers who were recruited using printed and digital advertisements. People were allowed to participate in the study if they were older than 18, had a smartphone, and had an account on at least one social network site.

Taking into account our number of level 1 observations (n = 15 time points), we aimed to recruit 100 participants as this allows to identify small-sized effects at level 1 (within-persons relationship between communication modes), medium-sized effects at level 2 (between-persons relationship between communication modes), and medium-sized cross-level interactions (interaction between experimental phase and mindfulness intervention) (Arend & Schäfer, 2019). These effect sizes are consistent with prior work on the social displacement hypothesis within-persons (Kross et al., 2013; Verduyn et al., 2015) and between persons (Ahn & Shin, 2013; Chan, 2018; Kim, 2017). Moreover, mindfulness interventions have been shown to have medium sized effects on emotional outcomes such as depression and anxiety (Khoury, Sharma, Rush, & Fournier, 2015) and correlational research shows medium-sized relationships between mindfulness and problematic smartphone use (Elhai et al., 2018; Kircaburun et al., 2019).

Anticipating possible attrition, we oversampled and recruited an initial sample of 121 participants contributing in total 1539 cases. A total of 505 cases were removed because of the following reasons: not possible to match case to participant (n = 7), opening but not completing questionnaire (n = 2), backfilling (i.e., completing an evening questionnaire the next day(s); n = 483), and completing questionnaires beyond the 15-day study period (n = 13). This resulted in a final dataset of 1034 cases provided by 109 participants (79 women, $M_{age} = 21.57$, $SD_{age} = 5.75$), 57 in the mindfulness training and 52 in the control condition.

To have a better understanding of the nature of panel attrition, we analyzed the extent to which panel attrition was systematic. Specifically, we took the data of all 121 people who had filled in at least the general questionnaire, computed the number of missing daily data entries (ranging from 0 to 15 for people who had not filled in data on a single diary day) and computed average levels of all outcome variables based on existing diary data per person. Then we inspected zero-order correlations of the number of missing diary entries with all outcome variables, age, and gender. There was no significant correlation of the number of missing diary entries with age ($r = -0.08$, $p = .38$), gender ($r = 0.01$, $p = .92$), smartphone communication ($r = 0.12$, $p = .21$), use of social network sites ($r = 0.08$, $p = .41$), and face-to-face communication ($r = -0.08$, $p = .41$). However, correlations with positive affect ($r = -0.21$, $p < .05$) and negative affect ($r = 0.32$, $p < .01$) were significant. This suggests that data was not fully missing at random. There is wide agreement that data can rarely be assumed to be missing at random (Newman, 2014; Wang, Beal, Chan, & Newman, Vancouver, Vandenberg, 2017). We therefore followed state-of-the-art recommendations on how to handle data with missing cases. Accordingly, we retained participants with missing data and used maximum likelihood estimation in our analyses (Hox, 2002; Newman, 2014; Raudenbush & Bryk, 2002; Singer & Willett, 2003; Wang et al., 2017).

2.3. Materials

Emotional well-being. The Scale of Positive And Negative Emotions (SPANE) (Diener et al., 2010) was used to measure emotional well-being. The SPANE consists of 12 emotion-terms with six items measuring positive affect (e.g., good, content) and six items measuring negative affect (e.g., bad, sad). Participants were asked to rate to what extent they experienced these emotions during the past day on a Likert-scale ranging from 1 (not at all/rarely) to 5 (very often/always). The reliability of the SPANE in the present study was good (Cronbach's alpha for positive affect = .87; Cronbach's alpha for negative affect = 0.85). Moreover, a multilevel confirmatory factor analysis confirms the two-dimensional structure of the SPANE in the present study (chi-square = 213.268; df = 106; $p < .001$; CFI = 0.98; TLI = 0.97; RMSEA = 0.03; $SRMR_{within} = 0.02$; $SRMR_{between} = 0.07$).

Smartphone communication. Participants were asked to indicate how many hours they spent communicating on their smartphone during the past day on a response scale ranging from a minimum of 0 h to a maximum of 12 h. Participants were explained that smartphone communication includes messenger, SMS, FaceTime, Whatsapp and social media amongst others. Unless the participant indicated 0 h, a follow-up question asked participants what percentage of this time they spent communicating on social network sites. Participants were explained that social network sites include Facebook, Instagram, Twitter, Snapchat, and LinkedIn amongst others. We transformed this percentage to hours for data-analysis. As such, we obtained information on the duration of overall smartphone communication and a subcategory of smartphone communication, namely social network sites.

Face-to-face communication. Participant were asked to indicate how many hours they spent interacting face-to-face during the past day on a response scale ranging from a minimum of 0 h to a maximum of 12 h. People were not asked to further decompose this overall amount of face-

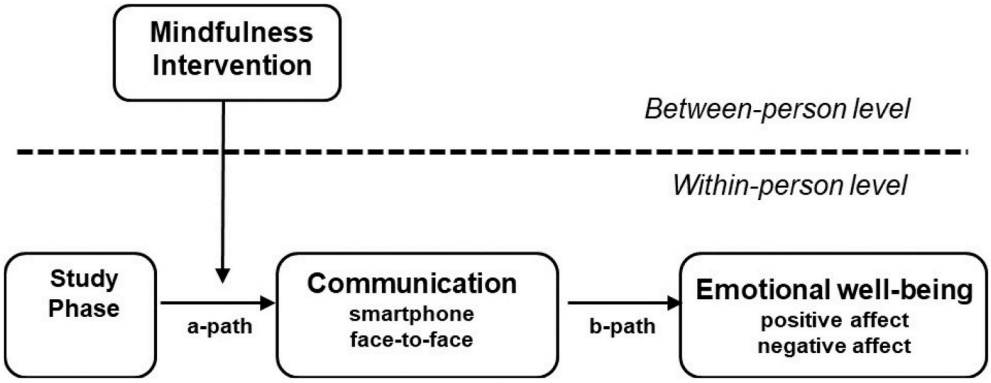

Fig. 1. Visualization of mediation pathway.

to-face communication into subtypes.

Mindfulness training. We made use of the 10-day self-training schedule developed and validated by Hülsheger and colleagues (Hülsheger, Alberts, Feinholdt, & Lang, 2013; Hülsheger, Feinholdt, & Nübold, 2015). This training consists of daily mindfulness meditation practices and informal exercises adapted from the Mindfulness-based stress reduction program (Kabat-Zinn, 1982) and Mindfulness-based cognitive therapy (Segal, Williams, & Teasdale, 2002). Exercises aim at cultivating an open and receptive awareness of present-moment experiences. Specifically, in guided meditation exercises, participants learn to deliberately bring attention to bodily sensations (e.g. the breath), thoughts or feelings. For instance, in the "Body Scan" exercise participants mentally "scan" through the body from head to toe while bringing attention to any sensations arising in the body and maintaining an accepting stance towards these sensations. The training was a self-training intervention that consisted of brief descriptions of the daily exercises and accompanying audio files. Since the original training (Hülsheger et al., 2013, 2015) was German, descriptions were translated into English. Furthermore, we used freely available English audio files of standard guided meditations ("Mindfulness of Body and Breath", "The Three-Minute Breathing Space", "The Befriending Meditation"; from *Mindfulness: Finding Peace in a Frantic World* (Williams & Penman, 2011). The participants were asked to follow at least 10 min of audio exercises every day, and this preferably in the morning.

2.4. Procedure

The study was presented to the participants as a 15-day diary study on mindfulness and (digital and non-digital) communication. At the start of each daily questionnaire, participants were told that non-digital communication pertains to face-to-face interactions while digital communication pertains to smartphone communication.

Participants were randomly allocated to a control or mindfulness intervention condition. Participants who were allocated to the control condition received an email each evening of the study period (day 1–15) asking them to complete (after 7.00 p.m.) the daily emotional well-being and communication questionnaires. Participants who were allocated to the mindfulness intervention condition similarly received an email asking them to complete these questionnaires during the first five evenings of the study (baseline: day 1–5). From day six onwards (intervention period: day 6–15), these participants received an email every morning (sent at 6.00 a.m.), containing instructions for mindfulness exercises that they were asked to do during the day. The evening questionnaire was identical to the questionnaire completed at baseline with the exception of the first item asking participants whether they had engaged in mindfulness exercises during the past day. If participants responded they did not do so (4.1% of the cases), they were encouraged to do the exercises first before continuing to complete the evening questionnaire. To avoid that differences between both conditions would be due to participants realizing they were in the treatment or control condition, all participants were told that the daily evening questionnaire asking them to recollect and report their emotions is a type of mindfulness exercise.

2.5. Data-analysis

Due to the multilevel nature of the data (days nested in persons), we tested hypotheses with multilevel analyses using a multilevel structural equation modelling framework in Mplus 8 (Muthen & Muthen, 2017) that partitions variance into latent within- and between-person components. While condition was a person-level variable (Level 2) that varied between persons, all other variables (i.e. study phase, smartphone and face-to-face communication, positive and negative affect) were day-level variables (Level 1) that varied within and between persons.

Within- and between-person correlations between the measured variables were assessed by specifying correlations simultaneously at both levels of analysis in Mplus8. To test for differences in correlations between levels, we used the model constraint function.

To test effects of the mindfulness training on communication and on emotional well-being, we conducted a series of multilevel path models applying growth modelling procedures as described in Bodner and Bliese (2018, see also Bolger & Laurenceau, 2013; Raudenbush & Bryk, 2002). In addition to random intercepts, we specified a random effect of study phase (i.e., phase 1: days 1–5 vs. phase 2: days 6–15) on the respective dependent variable (i.e., smartphone communication, face-to-face communication, positive and negative affect) at the within-person level, and an effect of condition on the random slope and on the respective intercept of the dependent variable at the between-person level. A significant cross-level interaction between condition and study phase on the respective dependent variable would provide support for our hypotheses as it would indicate that changes in dependent variables over time, i.e., from phase 1 (days 1–5) to phase 2 (days 6–15), are a function of condition. To assess the form of change within each condition, we used model constraints to estimate simple slopes within each condition. This procedure corresponds to a "difference in mean change approach", an analytical procedure that has been advocated in the literature for the analysis of intervention effects in randomized controlled trials as it provides information on intervention effects as well as on change over time (Bodner & Bliese, 2018). We also follow the authors' explicit recommendation to use one-tailed tests when hypothesizing directional effects (i.e., decrease in smartphone communication and negative affect and increase in face-to-face communication and positive affect) (Bodner & Bliese, 2018) and therefore used a one-tailed test to assess significance of the cross-level interaction (and associated simple slopes) between study phase and condition.

To test the prediction that effects of the mindfulness training on emotional well-being are mediated by changes in smartphone use and face-to-face communication, we extended the models described above to multilevel mediation models (Preacher, Zyphur, & Zhang, 2010) with lower-level mediation (e.g., study phase → smartphone communication → negative affect) and a cross-level moderator of the a-path. Specifically, we simultaneously estimated the within-person level a-path (e.g., study phase → smartphone communication), the b-path (e.g., smartphone communication → negative affect), and the c'-path (e.g., study phase → negative affect), while including condition (mindfulness vs. control) as the cross-level moderator of the a-path and specifying direct effects of condition on the mediator (smartphone communication or face-to-face communication, respectively) and on the dependent variable (negative affect or positive affect, respectively). Using model constraints, we estimated the indirect effect within each condition (mindfulness vs. control) as the product of the respective a- and b-path estimates within each condition. To assess significance of the indirect effects we followed Preacher and colleagues' (Preacher et al., 2010) recommendations and used parametric bootstrap procedures, yielding 95% confidence intervals around the indirect effect. To rule out confounding day-of-the-week effects, we controlled for day of the week (coded as 0 = Monday to 6 = Sunday) in all multilevel path analyses (Gabriel et al., 2019).

3. Results

Descriptive statistics are presented in Table 1. It is notable that participants' level of positive affect was higher than their level of negative affect. Moreover, participants engaged in face-to-face interactions about twice as often as they communicated through their smartphones. Almost half of the time that participants spent communicating on their smartphones was spent on social network sites.

Table 1
Correlations among study variables.

		Cronb. Alpha	*M*	*SD*	*ICC*	1	2	3	4	5
1	Positive Affect	.87	3.58	.68	.36		-.59***	-.19***	.32***	-.18***
2	Negative Affect	.85	1.88	.70	.39	-.55***		.14***	-.18***	.17***
3	Smartphone communication	–	3.03	1.91	.40	-.05	.17		-.32***	.65***
4	Face-to-face communication	–	5.87	2.68	.37	.25*	.08	.17		-.30***
5	Use of social network sites	–	1.47	1.36	.44	-.09	.21	.80***	.21	

Note. $N = 109$ individuals, 1034 observations. Correlations at the between-person level are indicated in the lower triangle, correlations at the within-person level are indicated in the upper triangle.
$^{**}p < .01$; $^{***}p < .001$; $^{*}p < .05$ (two-tailed).

3.1. How is smartphone communication related to face-to-face communication?

As Table 1 demonstrates, at the within-person level of analysis the relationship between face-to-face communication and smartphone communication was negative ($r = -.32$; $p < .001$). Similarly, the correlation between face-to-face communication and use of social network sites on smartphones was negative as well ($r = -0.30$; $p < .001$). These results illustrate that the social displacement hypothesis holds at the within-person level of analysis.

In contrast, at the between-person level of analysis these relationships were quite different: the relationship between face-to-face communication and smartphone communication was positive but non-significant ($r = .17$; $p = .163$), while the relationship between face-to-face communication and use of social network sites on smartphones was positive and marginally significant ($r = .21$; $p = .065$).

Moreover, these differences between results generated from the within-person and between-person levels of analyses were significantly different from one another (relationship face-to-face communication and smartphone communication: difference within vs. between: $p < .001$; relationship face-to-face communication and use of social network sites on smartphones: difference within vs. between: $p < .001$).

In sum, these analyses demonstrate that on days when people communicate a lot via smartphones (i.e., more than they usually do), they engage in less face-to-face interactions (within-persons: social displacement hypothesis confirmed). However, people who tend to spend a lot of time communicating on their smartphone do not engage less in face-to-face interactions than people who tend to largely refrain from smartphone communication (between-persons: social displacement hypothesis disconfirmed).

3.2. Do smartphone and face-to-face communication relate differentially to emotional well-being?

An inspection of zero-order correlations at the within-person level (Table 1, upper triangle) reveals that face-to-face interactions are positively related to positive affect ($r = 0.32$; $p < .001$) and negatively related to negative affect ($r = -0.18$; $p < .001$). In contrast, communication through smartphones is negatively related to positive affect ($r = -0.19$; $p < .001$), and positively related to negative affect ($r = 0.14$; $p < .001$). Use of social network sites on smartphones is also negatively related to positive affect ($r = -0.18$; $p < .001$) and positively related to negative affect ($r = 0.17$; $p < .001$). When considering smartphone communication (or use of social network sites on smartphones) and face-to-face communication jointly in a multilevel analysis to account for their intercorrelation, the pattern of results remained the same (see Supplementary analysis).

Echoing the results presented earlier, however, analyses performed at the between-person level revealed a different set of findings (Table 1, lower triangle). Specifically, at the between-person level, neither face-to-face communication nor smartphone communication were significantly related to emotional well-being, except for face-to-face communication being positively related to positive affect.

3.3. Does a mindfulness intervention reduce smartphone communication?

As expected (see Table 2 and Table 3), condition interacted with study phase to predict smartphone communication ($B = -0.55$; $p < .01$). An analysis of the simple main effects showed a significant decrease in smartphone communication for participants in the mindfulness condition ($B = -0.41$; $p < .01$) but not for participants in the control condition ($B = 0.14$; $p = .36$).

The mindfulness intervention was primarily intended to impact smartphone communication (and face-to-face communication) but we also explored whether the intervention impacted use of social network sites on smartphones. Interestingly, we did not observe an interaction between condition and study phase when predicting social network usage ($B = -0.14$; $p = .18$). Both in the control condition ($B = 0.00$, $p = .98$) and in the mindfulness condition ($B = -0.13$, $p = .11$), no significant changes in use of social network sites were observed.

3.4. Does a mindfulness intervention increase face-to-face communication?

There was no significant interaction (see Tables 2 and 3) between study phase and condition in predicting face-to-face communication ($B = 0.33$; $p = .17$). However, it is notable that participants in the treatment group showed a significant increase in face-to-face communication ($B = .57$; $p = .01$) while participants in the control group did not ($B = 0.24$; $p = .31$).

3.5. Does a mindfulness intervention increase emotional well-being?

As expected (see Tables 2 and 3), condition interacted with study phase to predict negative affect ($B = -0.19$; $p = .01$). An analysis of the simple main effects showed a significant decrease in negative affect for participants in the mindfulness condition ($B = -0.20$; $p < .001$) but not for participants in the control condition ($B = -0.02$; $p = .78$). In contrast, the interaction between condition and study phase was not significant when predicting positive affect.

3.6. Does a decrease in smartphone communication mediate the impact of a mindfulness intervention on negative affect?

Next, we examined whether the effect of mindfulness training on negative affect was mediated by the observed decrease in smartphone communication. This was found to be the case: the indirect effect of study phase (days 1–5 vs. days 6–15) on negative affect through smartphone communication was significant in the mindfulness group ($B = -0.02$; CI: lower bound -0.041; upper bound -0.003) while it was not in the control group ($B = 0.01$; CI: lower bound -0.008; upper bound .025).

3.7. Does an increase in face-to-face communication mediate the impact of a mindfulness intervention on negative affect?

Finally, although the interaction between study phase and condition in predicting face-to-face communication was not significant (see

Table 2
Descriptive Statistics by Condition and Study Phase.

	Mindfulness condition				Control condition			
	Phase 1		Phase 2		Phase 1		Phase 2	
	M	SD	M	SD	M	SD	M	SD
Smartphone communication	3.11	1.82	2.57	1.57	3.10	1.94	3.32	2.14
Use of social network sites	1.47	1.19	1.18	1.13	1.54	1.38	1.65	1.56
Face-to-face communication	5.54	2.49	6.16	2.51	5.65	2.85	5.98	2.79
Positive Affect	3.49	.64	3.54	.72	3.58	.69	3.66	.66
Negative Affect	1.93	.69	1.70	.67	1.98	.74	1.94	.67

Note. $N = 109$ individuals, 1034 observations; Phase 1 = day 1–5; Phase 2 = day 6–15.

Table 3
Multilevel Models Predicting Changes in Communication and Affect depending on Experimental Condition.

	Smartphone communication	Face-to-face communication	Use of social network sites	Positive affect	Negative affect
Fixed effects					
Intercept	3.21*** (.21)	5.57*** (.28)	1.56*** (.15)	3.58*** (.07)	2.04*** (.08)
Day of the week	-.03 (.02)	.04 (.03)	.00 (.02)	.00 (.01)	-.02 (.01)
Phase[a]	.14 (.15)	.24 (.23)	.00 (.10)	.05 (.06)	-.02 (.06)
Condition[b]	.01 (.27)	-.17 (.37)	-.07 (.20)	-.10 (.09)	-.01 (.10)
Phase x Condition	-.55** (.23)	.33 (.34)	-.14 (.15)	-.09 (.09)	-.19** (.08)
Random effects					
Intercept	1.34*** (.24)	2.43*** (.46)	.78*** (.14)	.15*** (.03)	.18*** (.03)
Slope Phase	.22 (.15)	.68* (.33)	.08 (.06)	.07** (.03)	.02 (.02)
Simple slopes					
Mindfulness group	-.41** (.16)	.57* (.25)	-.13 (.11)	-.04 (.07)	-.20*** (.06)
Control group	.14 (.15)	.24 (.23)	.00 (.10)	.05 (.06)	-.02 (.06)

Note. $N = 109$ individuals, 1034 observations.
***$p < .001$; **$p < .01$; *$p < .05$; All estimates are unstandardized and were tested two-tailed except for phase x condition and the corresponding simple slopes for which a one-tailed test was used as described in the method section and as recommended by Bodner and Bliese (Bodner & Bliese, 2018).
[a] Phase coded as 0 = baseline (day 1–5); 1 = intervention (day 6–15).
[b] Coded as 0 = control group, 1 = mindfulness group. Standard Error is indicated in brackets. Day of the week coded as 0 = Monday, 1 = Tuesday, 2 = Wednesday, 3 = Thursday, 4 = Friday, 5 = Saturday, 6 = Sunday.

findings reported above), it is worth noting that the indirect effect of study phase on negative affect through an increase in face-to-face communication was significant in the mindfulness group (B = −0.03, CI: lower bound −0.053; upper bound −0.006), while it was not in the control group (B = −0.01, CI: lower bound −0.032; upper bound .009). However, it should be stressed that this finding has to be interpreted with caution, because of the non-significant interactive effect of study phase and condition on face-to-face communication.

4. Discussion

A recent article in Forbes magazine posed the question: “Has technology killed face-to-face communication” (Goman, 2018)? Similarly, an article in the Guardian was titled: “Have smartphones killed the art of conversation” (Iqbal, 2018)? While these headlines do not constitute evidence by themselves, they do reflect a public concern that smartphones may replace face-to-face interactions. Research is needed to examine whether these concerns are warranted to provide evidence-based recommendations of healthy smartphone use.

The first aim of the present study was to examine whether the social displacement hypothesis, which suggests that smartphone communication displaces face-to-face interactions, holds true. Our results demonstrate that the validity of the social displacement hypothesis critically depends on the level of analysis. The relationship between smartphone and face-to-face communication was negative at the within-person level of analysis but not the between-person level of analysis. This pattern of results indicates that when a person spends a lot of time (i.e., more than she usually does) communicating on a smartphone during a particular day, this same person will engage in less face-to-face interactions during that same day. However, people who generally tend to spend a lot of time (i.e., more than other people typically do) communicating on their smartphone do not generally engage in less face-to-face conversations than people who tend to largely refrain from smartphone communication.

When focusing on usage of social network sites on smartphones, we even observed a marginally significant positive relationship with face-to-face communication at the between-person level of analysis. This suggests that the social displacement versus social augmentation dichotomy is a false dichotomy as each hypothesis may be valid at a different level of analysis. Moreover, the pattern of results indicates that avid smartphone users are not a socially isolated group of people, but rather, that spending a lot of time communicating on a smartphone on a particular day is associated with less face-to-face interactions during that same day.

Daily smartphone and face-to-face communication do not only correlate negatively within-persons but are also differentially related to how one feels on the day in question. Daily smartphone communication was negatively related to emotional well-being while face-to-face interactions predicted increased levels of emotional well-being. It should be noted, however, that these results do not imply that smartphone communication always results in negative outcomes. A large number of studies demonstrated the unique affordances of smartphones (e.g., Camacho et al., 2014; Godwin-Jones, 2011; White et al., 2011) but the present results suggest that the relationship between smartphone communication and emotional well-being overall is negative, at least at the within-person level. This is consistent with research on social network sites showing that these online platforms can foster emotional well-being but that people typically use them in ways that undermine their happiness resulting in an overall negative relationship between use of social network sites and emotional well-being (Verduyn, Ybarra, Résibois, Jonides, & Kross, 2017).

The second aim of the present study was to examine a theory-based

intervention that may protect people from the negative affective consequences associated with the social displacement hypothesis. We found that a mindfulness intervention reduced the amount of time people spend communicating on their smartphone each day. Moreover, this decrease in smartphone communication within-persons mediated the positive effect of the mindfulness intervention on emotional well-being. This suggests that mindfulness indeed protects people from the negative affective consequences associated with the social displacement hypothesis.

While the present study adds to our understanding of the social displacement hypothesis, it also has a number of limitations. First, in the present study, we focused on social use of smartphones but smartphones can also be used for non-social purposes. Future research is necessary to examine the relationship between non-social smartphone use and face-to-face interactions as well as the impact of mindfulness interventions on non-social smartphone use.

Second, social usage of smartphones in itself is a broad category encompassing many communication subtypes including social network sites, texting, voice calls and video calls. The relationship between each of these subtypes of smartphone communication and face-to-face interaction should be examined in future research.

Third, in the present study we ran separate analyses on one popular subtype of social use of smartphones, namely social network sites. However, while communicating on social network sites, people may predominantly take an active role sending information to others, or a more passive role acting primarily as a receiver consuming the information provided by others (Verduyn et al., 2017). Future research is needed to examine whether active and passive use of social network sites have differential implications for the quantity of face-to-face interactions.

Fourth, future research may also examine subtypes of face-to-face communication. For example, a distinction could be made between voluntary and involuntary face-to-face communication. While during certain periods (e.g., holidays) people are free to decide whether to engage in face-to-face communication or not, during other periods (e.g., workdays) face-to-face communication may be dictated by circumstances. Specifically, certain jobs require people to interact with others face-to-face for most of the day, leaving limited time left for smartphone communication (e.g., medical staff). Moreover, the voluntary (vs. involuntary) nature of face-to-face communication may have consequences for the impact of face-to-face communication on indicators of well-being. Specifically, while voluntary face-to-face interaction may generally foster well-being, this may be less the case for face-to-face communication dictated by job requirements.

Finally, it is noteworthy that we only found weak evidence that the mindfulness intervention increased face-to-face interactions. This implies that the time people used to spend communicating on their smartphone before the mindfulness intervention was not fully replaced by face-to-face interactions. One possible explanation is that following the mindfulness intervention, people used their smartphone less during periods in which they were also engaging in face-to-face interactions (i.e., less co-present device use). Alternatively, people may spend the time that has become available by engaging less in smartphone communication, on non-social activities. Future studies are needed to better understand which new activities compensate for the drop in smartphone communication following mindfulness training.

5. Conclusion

More than twenty years ago, people worried that the internet would displace face-to-face interactions which led to a lot of debate (Kraut et al., 1998, 2002). More recently, the widespread use of smartphones has led to similar concerns. We demonstrated that this concern is partially justified. When one spends a lot of time communicating on one's smartphone on a particular day, one will invest less time in face-to-face interactions during that same day. However, people who generally communicate a lot through smartphones do not engage in less face-to-face interactions than people who only occasionally communicate using their smartphone. Mindfulness reduces the amount of time people spend communicating on their smartphone during the day, which increases their level of emotional well-being.

CRediT authorship contribution statement

Philippe Verduyn: Conceptualization, Methodology, Writing - original draft, Writing - review & editing, Supervision. **Julia C.C. Schulte-Strathaus:** Conceptualization, Methodology, Investigation, Data curation, Writing - review & editing. **Ethan Kross:** Conceptualization, Writing - review & editing. **Ute R. Hülsheger:** Conceptualization, Methodology, Formal analysis, Writing - review & editing.

Declarations of competing interest

None

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chb.2020.106550.

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