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A dyadic multimethod study of "partner phubbing", smartphone conflict, and relationship quality in opposite-sex couples from Belgium

Floor Denecker[1] · Michal Frackowiak[1,2] · Simon Perneel[1] · Mariek Vanden Abeele[1] · Koen Ponnet[1] · Lieven De Marez[1]

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Abstract
Existing research indicates that 'partner phubbing' is associated with heightened conflict and lower relationship satisfaction. However, previous studies have relied on cross-sectional designs involving subjective self-reports of only one partner. In this study, the main hypothesis entailed that the link between partner phubbing and relationship quality will be mediated by conflict over smartphone use. We utilized experience sampling (ESM) with objective smartphone logging measures collected over 14 days from 35 mixed-gender intimate dyads from Belgium ($N = 70$). An Actor-Partner Interdependence Model revealed that perceived relationship quality was negatively predicted by partner's smartphone use in husbands only, but there were no indirect effects via smartphone conflict. We reported a low occurrence of smartphone frustration and conflict in couples. An outstanding dyad analysis revealed some incongruencies between partner's smartphone use and its perception within couples. The design allowed us to distinguish between phone use frequency and screen time, which facilitated a nuanced understanding of smartphone use impact, and gender differences, to some extent refuting the previous literature. The findings prompt us to debate whether co-present smartphone use ought to be associated with negative outcomes exclusively, a rare notion to be explored in future research.

Keywords Co-present smartphone use · Partner phubbing · Smartphone-related conflict · Smartphone logging · Experience sampling · Intimate relationships

Introduction

Smartphones have become an essential part of the daily functioning of intimate relationships. Partners may use smartphones whilst together, resulting in co-present phone use (Kelly & Miller-Ott, 2022). The occurrence of such situations has led to the establishment of a new field of research exploring the use of smartphones during quality couple time (Roberts & David, 2016). This has predominantly been studied under the term "phubbing" (phone snubbing), under the assumption that one feels "snubbed" due to the partner's device use (Chotpitayasunondh & Douglas, 2016). Studies show that such smartphone use can generate negative relational consequences, including decreased relationship quality (David & Roberts, 2021), intimacy (Amichai-Hamburger & Etgar, 2016), conversation quality (Roaché et al., 2020), as well as increased conflict over technology use (McDaniel & Drouin, 2019).

Yet, the existing evidence on the impact of smartphone use on relationship-related constructs is largely based on cross-sectional designs and self-reports, which can lead to erroneous conclusions. Additionally, most studies rely on the participation of only one partner. In the present study, our aim is to explore consequences of smartphone use in couples, via a multimethod design that complements dyadic

Floor Denecker and Michal Frackowiak share the first Authorship.

✉ Michal Frackowiak
michal.frackowiak@unil.ch

[1] imec-mict-UGent, Faculty of Social Sciences, Ghent University, Ghent, Belgium

[2] Institute of Psychology, Faculty of Social and Political Sciences, University of Lausanne, Lausanne, Switzerland

cross-sectional surveys with the combination of smartphone logging and experience sampling.

The impact of co-present phone use on relationships

Smartphones have spilt over relationships' daily lives and changed the way partners function in several ways. Smartphones use can create challenges in relationships if not moderated, especially in a partner's physical co-presence. Initial reports demonstrate that the mere presence of a smartphone can jeopardize interactions, especially when partners are in the middle of a meaningful conversation (Przybylski & Weinstein, 2013).

The rising concern that co-present technology use is replacing face-to-face interactions has been reflected in a new area of empirical research (Hertlein & Blumer, 2014). Studies exploring "phubbing" (phone snubbing) focus on situations during which one feels ignored by the partner's co-present engagement with a smartphone (Chotpitayasunondh & Douglas, 2016). Co-present use of smartphones has also been conceptualized as "technoference", which refers to the general interruptions of technological devices in social situations (McDaniel & Wesselmann, 2021). The construct of phubbing shows strong conceptual and operational overlap with technoference, which is visible in the terms often being applied interchangeably.[1]

Given that co-present smartphone use may lead to divided attention from a partner, the other who feels phubbed, may experience frustration over their partner's smartphone use. This feeds into the notion that phubbing may take away quality time and can make the person experiencing phubbing feel left out and unimportant (Thomas et al., 2022). Frustration and conflict are closely linked in intimate relationships. As a result of creating an artificial social distance between partners due to technology use, partners may suffer from effective communication shortage, and experience conflict over technology use, which is documented in the literature (Beukeboom & Pollmann, 2021; Halpern & Katz, 2017; McDaniel & Drouin, 2019; Roberts & David, 2016). Thus, it is relevant, as the previous studies have emphasized, to consider the role of "conflict" over smartphone use as a potential mediator between experiencing phubbing and relationship quality. The potential increase in frustration and the construct's proxies have been studied (Frackowiak et al., 2024a, Thomas et al., 2022), but to our knowledge, no study has combined smartphone-related frustration and conflict in a study.

[1] We acknowledge that the term "phubbing" remains subject to debatable conceptualization and measurement. Researchers have attributed it to an a priori assumption of co-present smartphone use being necessarily associated with negative impact (see Davidson et al., 2022; Frackowiak et al., 2023; Hagger, 2014 for commentaries).

However, some evidence contradicts the prevailing view on the negative impact of smartphone use in relationships. Some authors suggest that what matters in comprehending the genuine impact of smartphone use on relationships is the role of a smartphone in these interactions, as it can be facilitatory (e.g., Cummings & Reimer, 2021). It has been found, for instance, that partners may use mobile phones as a source of emotion regulation in de-escalating the conflict, and maintaining a sense of connection, hence fostering closeness and intimacy (Caughlin et al., 2016). Salmela et al. (2019) interviewed couples and reported that the effect of smartphone use in bed depended on whether it was shared or independent. Some participants expressed their frustration with their partner's smartphone use, but to reduce the potential conflict, they negotiated their patterns of phone usage. The notion of shared smartphone use between partners is in its infancy, but several papers have indicated that involving partner in smartphone-related activities contrary to giving them a 'cold shoulder' may promote relationship maintenance rather than put it at risk (e.g., Frackowiak et al., 2024b; Kelly et al., 2017; Kelly & Miller-Ott, 2022). Foster Campbell (2022) has also brought up the *implicit rules* around technology use that are established between partners as the relationship develops, and depend on having children or not, suggesting that the relationship duration and living together are relevant explanatory factors. Hence, it can be questioned whether *any* co-present phone use by partners warrants a menace to the relationship welfare.

Theoretical frameworks

To explain the role of smartphones in partner interactions, we draw from the recently developed theoretical frameworks, The Cellphone Relevance Hypothesis (Cummings & Reimer, 2021) and the Attention Arousal Attribution Framework (Vanden Abeele, 2020). The former suggests that the impact of co-present phone use depends on its function within a conversation, that is, whether it is integral (relevant to the conversation) or incidental use (irrelevant to the conversation; Cummings & Reimer, 2021). We can debate that using the phone in presence of one's partner to look up information related to the interaction may not provoke frustration and conflict over smartphone use as much as it would, should the use be unrelated to the interaction. This theory facilitates a contextual distinction between harm*ful* and harm*less* phone-related behaviors.

On the other hand, Vanden Abeele (2020) postulates that the negative relational consequences of phubbing are a product of attention shifts, emotional arousal, and interpretations of the situation. Amongst those factors, the Author also brings up amplifying and mitigating factors, such as relational characteristics and contextual circumstances. For

instance, the Author argues that the relationship length may be pertinent in defining the extent to which phone use promotes relational harm, as partners may gradually develop their own behavioral norms with time. Additionally, they implied that the importance of phubbing duration may play a role, i.e., a short period of snubbing due to the phone use may be acceptable, but when repeated or prolonged, such behavior may be seen as a violation.

Insights from novel methodologies

Experience sampling method (ESM)

While theoretical frameworks provide insights into the interpersonal processes and relational consequences of partner phubbing, it is essential to employ a rigorous methodology to draw accurate conclusions. Partners interact with each other frequently, daily, and the co-present phone use is inevitable in those interactions (Foster Campbell, 2022). However, the existing research– predominantly cross-sectional– imposes limitations on the conclusions and implications drawn from findings. Consequently, we emphasize the importance of examining smartphone-related behaviors in couples as they naturally unfold in the daily couples' environments. This can be facilitated by the experience sampling method (ESM).

Several ESM studies have explored phubbing and co-present smartphone use in couples. However, findings are at times contradictory, hence a simple conclusion cannot be drawn from those publications. For example, Frackowiak et al. (2022) collected data from participants over seven evenings. The results show no direct association between partner phubbing and end-of-day relationship satisfaction but mediated by perceived partner responsiveness and moral judgment (Frackowiak et al., 2022). On the contrary, Thomas et al. (2022) conducted a study over nine evenings and found a direct negative association between partner phubbing and relationship satisfaction. However, whilst these results may be diverging, participants in both Thomas et al. (2022); Frackowiak et al. (2024a) reported higher levels of anger and frustration when they experienced a partner's smartphone use. Finally, Zoppolat et al. (2022) measured "technoference" in relationships for 10 days during a COVID-19 lockdown and found no direct link of partner's (or own) smartphone use on relationship satisfaction. Rather, the association was mediated by a conflict with the partner.[2]

There have been few ESM studies that recruited dyads. McDaniel et al. (2021) found during their 10-day study a small indirect effect of partner technology use on relationship satisfaction via leisure conflict. McDaniel and Drouin (2019) measured daily technoference in dyads, over two weeks. On days where there was more technoference, participants reported lower relationship quality and more conflict over technology use. However, on the between-person level, experiencing technoference was not associated with relationship quality. Finally, Carnelley et al. (2023) developed a 14-day study and a two-month follow-up. In the analysis, they applied an Actor-Partner Interdependence Model to consider potential differences in "actor" and "partner" effects. This study significantly enhances our understanding of the topic by examining "partner effects", a dimension often overlooked in previous research, since partners mutually influence each other.

Smartphone log data

Despite the prominence and advantages related to the use of ESM in data collection, the design remains subject to participant bias, due to its self-reporting nature (Van de Mortel, 2008). To address this issue of social desirability bias, recent trends in the collection of smartphone measures have shifted toward passive measures of smartphone use, a practice now commonly referred to as *smartphone logging* (Miller, 2012). It has become a tool for collecting behavioral data that is an objective and unobtrusive indicator of trends and ways in which smartphones are used (Boase, 2013). These measures are not biased by the sentiments of participants. In the current research, smartphone log data will provide us with a more accurate estimate of participants' smartphone use on a particular day and will allow us to add the context to these measures, i.e., couples' co-present smartphone use.

Smartphone logging and experience sampling have previously been combined to study online vigilance and daily well-being (Johannes et al., 2021). To our best knowledge, however, only one study has combined ESM and smartphone logging to study co-present smartphone use in interactions. The study of Denecker et al. (2023) combines two types of data collected from parents of children aged 4-10 to assess associations between the frequency and duration of co-present parental smartphone use and parents' perceptions of quality time, their child's restlessness, technoference, and time displacement.

[2] We would like to note that, consistently with our argument in the section "Smartphones' Impact on Relationships", the ESM and daily diary studies are also subject to questionable operationalizations of the phenomenon. For instance, Frackowiak et al. (2022, 2024b) asked participants about perceived co-present smartphone use by a partner (conceptualized as "phubbing" but operationalized as "perceived intensity of co-present phone use by a partner"). Zoppolat et al. (2022), on the other hand, defined and operationalized "technoference" explicitly as perceived partner's phone use, though the term assumes *any* technological device.

The current study

Objectives

The current study has been pre-registered (link to the OSF repository: https://bit.ly/41y7azW) and has three aims. First, we aim to test the pre-registered hypotheses. At the time of pre-registration, we devised the hypotheses based on the previous literature, to address them using a dyadic study design (obtaining *actor* and *partner* effects). We aimed to test the influence of *feeling phubbed* on *perceived relationship quality*, with the investigation of its direct effect and mediated by *conflict over smartphone use*. The following hypotheses are described (see Fig. 1):

H1a: Feeling phubbed and smartphone conflict are negatively related to self-reported relationship quality.
H1b: Feeling phubbed is positively related to smartphone conflict.
H1c: Smartphone conflict is a mediator of the association between feeling phubbed and relationship quality.

In the second part of the study, we combined cross-sectional data, experience sampling, and smartphone logging. We conducted two exploratory analyses: firstly, we examined the hypothesized variables' potential connection with objective smartphone use to avoid estimation bias. Secondly, we explored how smartphone-induced frustration and conflict unfold in couples' daily lives, using an outstanding dyad analysis.

Multimethod rationale

To address the methodological shortcomings of the previous research, we employ a multimethod study framework. First, we applied a dyadic design to capture feelings and behavior of *both* partners. Few of the previous studies on smartphone use in a couple context have recruited dyads (for example Carnelley et al., 2023; McDaniel & Drouin, 2019). Dyadic dynamics in relationships ought to be examined, due to the *interdependence of partners* (Kenny et al., 2006), but methodological challenges and related costs often prevent researchers from collecting such data (Ponnet & Wouters, 2014).

Next, the present study utilizes intensive longitudinal data (Bolger & Laurenceau, 2013), combining the experience sampling method (ESM) and smartphone logging. Daily interaction-related processes are prone to rapid fluctuations, requiring a more systematic assessment that emphasizes intraindividual variability (Hamaker & Wichers, 2017). Unlike traditional cross-sectional methods of collecting data, ESM facilitates the collection of such data, by allowing repeated assessments of a person's feelings, thoughts, or behaviors, over a specific interval of time (Horstmann, 2021). Smartphone logging facilitates collection of unbiased objective measures of one's smartphone usage. These two methods have been argued in the literature to be some of the most robust methods to support scientific investigation of daily processes in participants' micro-environments (Harari et al., 2017).

Methods

Procedure

The data collection process was threefold: (1) participant intake and baseline survey, (2) experience sampling, and (3) smartphone logging. We elaborate on the procedures in the following subsections, which are accompanied by a visual

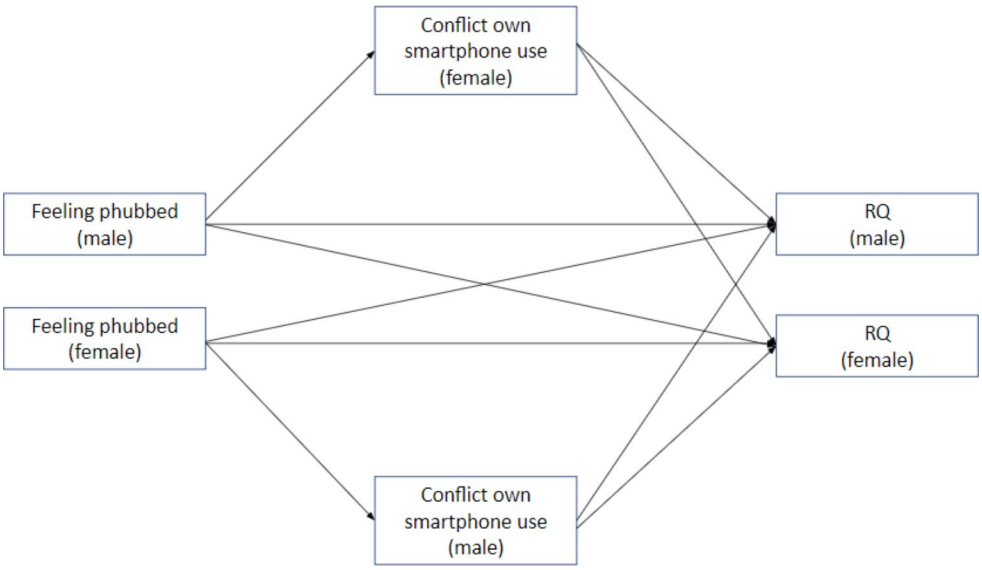

Fig. 1 Visualization of the hypothesized mediation model. *Note.* This hypothesized mediation model consists of the following paths, to be tested: path 1 (man, actor-level): feeling phubbed$_{male}$ → smartphone conflict$_{female}$ → relationship quality$_{male}$. path 2 (man, partner-level): feeling phubbed$_{female}$ → smartphone conflict$_{male}$→ Y$_{male}$. path 3 (woman, actor-level): feeling phubbed$_{female}$ → smartphone conflict$_{male}$ → relationship quality$_{female}$. path 4 (woman, partner-level): feeling phubbed$_{male}$ → smartphone conflict$_{female}$ → relationship quality$_{female}$

representation of the study flow and data collection process (see Fig. 2).

Stage 1: participant intake and baseline survey

This study was part of a larger research project, investigating the digital wellbeing of young parents on three levels of focus. We wanted to examine whether their smartphone use had an influence on (1) their personal wellbeing, (2) the interactions with their partner, and (3) the interactions with their children (see https://bit.ly/41y7azW for a project overview).

Participants were recruited based on the following eligibility criteria: (a) having at least one child aged 4-10 (not relevant to the current manuscript); (b) being married or living together with the partner of opposite gender; and (c) one of the couple had to use a smartphone with an Android operating system, as passive smartphone logging was done via an Android-only research application. Students ($n = 20$) were involved in this research project. Each of them had to recruit three couples from their environment (i.e., being the Dutch-speaking part of Belgium), who met the eligibility criteria. The students received course credits. In addition, some participants were recruited from the researchers' network.

Fig. 2 A graph demonstrating the study flow and data collection process

The students were trained to complete the intake procedure during an online call. The intake procedure starts with providing the participants with an explanation of the study procedure. They were also assisted in installing two smartphone applications, required for the data collection. One application was installed to passively log smartphone use, whereas another was installed for collecting experience sampling data. To ensure the proper linking of different datasets, they received the necessary research ID's during this installation process. It was also stressed that if the participants encountered any technical issues with the applications during the research period, they should contact the responsible researcher for further help. At the end of the intake phase, participants' informed consents were digitally collected, and a baseline survey was filled out. This marked the start of a 14-day study run.

At the beginning of the baseline survey, participants were asked to answer the questions and to not discuss them with their partner. First, we double-checked the eligibility criteria via some questions. These variables were used for cleaning. Next, we posed questions about demographic characteristics of the participant (see table A here: https://bit.ly/3Ng2IzW). Our sample included 70 unique participants, formed by 35 mixed-gender couples, whereas initially 118 individuals were contacted by the students[3].

Furthermore, we checked the characteristics of the couples' households, by asking about the number of children within their household, and time living together (see table B on https://bit.ly/3Ng2IzW). The remaining variables of interest for this study were measured using validated instruments on a 5-point Likert scale (see further).

Stage 2: experience sampling

During the study run, participants received notifications from an application Ethica at fixed times each day (at 08h00, 18h00, and 19h30), asking them several questions. If the participant did not respond to the survey after the first notification, they received three reminders within an hour. The questionnaire expired after 60 min. The notifications were purposefully programmed at that timing during a day, to target moments where participants had likely been in the company of their partner during the previous hour. In other words, we avoided triggering participants during the normative working hours.

In the experience sampling surveys, we asked participants if they spent time with their partner during the previous hour (percentage of "yes" answers: 61.94% on average,

[3] Due to the specific criteria that our data needed to fulfill for analysis, we experienced participant attrition.

over all surveys). Hence, we were able to measure the level of smartphone use in others' co-presence and to inquire about the feelings linked to co-present smartphone use at that specific moment. This means that questions about experienced smartphone frustration and conflict were only posed when participants indicated that they had spent time with the partner the hour before.

Fig. 3 Start screen of MobileDNA application developed by Ghent University (Belgium)

Stage 3: smartphone log data

Throughout the course of the study, the mobileDNA application was used to passively record the activity on the participants' Android smartphones. The initial screen that participants saw is depicted in Fig. 3. It included a 'view your data' button, which allowed participants to gain insights into their smartphone usage. However, participants did not have access to the raw data collected in the back end. This detailed raw data was exclusively available to the researchers, providing them with a comprehensive understanding of an individual's smartphone usage.

Our data collection process is detailed and operates on multiple levels. The first level involves the mobileDNA app, which records data on smartphone sessions. A session is defined as the period from when a user unlocks their smartphone to when they lock it again. Each session is made up of various app events, and within each session, we collect data on the sequence of apps used, the length of the session, the specific time the session occurred, and whether a notification initiated the session. At the second level, we collect data about app events, which includes all information related to the use of a specific app on the smartphone. For every instance of app use, we gather the following information: the name of the app, the location, the battery percentage, the type of smartphone, and whether a notification prompted the use of the app. These raw measures allow us to calculate several variations of duration and frequency variables at different levels.

Measures

Baseline survey

Years of living together Participants were asked to indicate in numbers how many years they were already living together. On average, participants had lived together for 11.29 years (SD = 2.99, range = 6-19 years). This variable functions as a control variable.

Number of children Participants were asked to indicate "how many children (both under and over 18 years old) are in your household?", via answer options ranging from "1 child" to "more than 10 children". It was mentioned that resident stepchildren, children over whom they have joint custody, and/or those who stay in boarding schools or dormitories during the week also counted as resident persons. We saw that 80% of the couples had two children, and the remaining 20% had three children together.

Relationship quality This was measured with the "Quality of Marriage Index" (QMI, Norton, 1983). An example item

is *"My relationship with my partner makes me happy"* (1 = *completely disagree*, 5 = *completely agree*). Internal reliability was high (α = 0.97).

Smartphone conflict To measure the conflict over smartphone use, we modified the phone related conflict scale of Halpern and Katz (2017) and used three items to measure participants' experience of conflict over their own smartphone use. A sample item is: *"How often do you and your partner discuss your smartphone use?"* (1 = *never*, 5 = *very often*). Internal reliability was high (α = 0.90).

Feeling phubbed We included nine items of the Partner Phubbing Scale (PPS) (Roberts & David, 2016) to inquire about to what extent the participant in general 'felt phubbed' by the partner's smartphone use). Participants were asked to think about the time they spend with their partner. Next, they were asked how often they find themselves in the outlined situations, for example *"My partner uses his/her smartphone when my partner and I are out together."* (1 = *never*, 5 = *very often*). Internal reliability was high (α = 0.93), after dropping one item. Table 1 shows the descriptive statistics of these three variables.

Experience sampling

Frustration and conflict over smartphone use If the participant reported the presence of their partner in the hour before receiving the notification, they were asked about smartphone frustration (*"To what extent have you been frustrated in the past hour by your partner's smartphone use?"*, 1 = *(almost) never*, *0 times* to 5 = *very often*, *10 times or more*) and another question about smartphone conflict (*"To what extent have you had a conflict in the past hour with your partner about his/her smartphone use?"*, 1 = *(almost) never*, *0 times* to 5 = *very often*, *10 times or more*). We dichotomized these two measures: "0" indicated that their participant mentioned no frustration/conflict about the partners' smartphone use during the previous hour, while "1" means that the participant did mention any level of smartphone frustration/conflict. In more than 90% of the co-present observations, "0" was reported, i.e., indicating no frustration over partner's smartphone use.

Smartphone logging

We calculated smartphone use measures at two different levels, being "average daily smartphone measures" and

Table 1 Descriptive statistics and correlations between traits of men and women, examined via baseline intake survey

		1.		2.		3.		4.	5.
	M (SD)	M	F	M	F	M	F		
1. Feeling phubbed	3.00 (0.89)								
Men	3.10 (0.93)	/	0.09	0.27	**0.46***	**-0.47***	-0.34	0.04	0.21
Women	2.89 (0.85)		/	**0.58****	0.02	0.05	-0.01	0.03	-0.28
2. Smartphone conflict	2.04 (0.80)								
Men	2.00 (0.68)			/	0.18	-0.11	-0.04	-0.27	0.32
Women	2.09 (0.91)				/	**-0.38***	-0.14	**-0.40***	0.10
3. Relationship quality	4.56 (0.76)								
Men	4.66 (0.59)					/	**0.81*****	0.02	0.49
Women	4.52 (0.90)						/	0.03	-0.13
4. Years of living together	11.29 (2.99)							/	0.02
5. Number of children	2.20 (0.41)								/

Note. The first column outlines the descriptive statistics of the three variables. M stands for "mean", SD stands for "standard deviation". The following column indicates the Pearson's correlation coefficients (*r*) at the actor- and partner level. The significance levels of the correlations are indicated via with *p <.05, **p <.01, ***p <.001

Table 2 Descriptive statistics and correlations between (daily averaged) measures of smartphone logging and baseline survey

	M (SD, range)	1.	2.	3.
1. Daily average screen time	128.69 (62.78, 14.66–274.44)	/	**0.39****	**0.58*****
2. Daily average sessions	90.65 (73.86, 12.00–469.33)		/	**0.65*****
3. Daily average app events	131.13 (77.31, 20.38–444.10)			/
4. Feeling phubbed				
Actor-level		0.27	0.01	0.01
Partner-level		**0.35****	0.12	0.12
5. Smartphone conflict				
Actor-level		**0.38****	0.16	**0.30***
Partner-level		0.23	0.11	0.03
6. Relationship quality				
Actor-level		**-0.68****	-0.01	**-0.41****
Partner-level		**-0.51*****	-0.07	-0.20
7. Years of living together		0.72	-0.20	-0.21
8. Number of children		-0.04	0.02	-0.02

Note. Linked to the descriptive statistics, the column outlines the mean (M), standard deviation (SD), and the minimum and maximum reported value of the participants (range). These descriptive statistics are only outlined for the first three - smartphone logging - variables, as the descriptive statistics of the other three - intake survey - variables are already mentioned in Table 3. Linked to the Pearson's correlation coefficients (r), the first row of each variable outlines the actor level correlations, while the second row offers additional insights in the partner level correlations. The correlations are only investigated with the first three variables, as the other three are already outlined in Table 3. Actor level correlations were investigated at the level of the smartphone-using participant: correlating smartphone use measures with the baseline measures. At the partner level, the smartphone use measures of the smartphone using participant is linked with the baseline measures of the other (n = 53). The significance levels of the correlations are indicated via with * p <.05, ** p <.01, *** p <.001

"timestamped co-present smartphone measures". The former is only based on logging data, while the latter can only be calculated by combining the raw data of smartphone logging and experience sampling.

Average daily smartphone measures For each participant, we calculated the average daily smartphone measures. These measures operationalized (a) "screen time", (b) "sessions" as well as (c) "app events". Screen time reflects the duration of smartphone use, while sessions and app events operationalize different aspects of the frequency of smartphone use, respectively the amount of smartphone sessions and the amount of app events, over these sessions. Table 2 shows the descriptive statistics of these variables.

Timestamped co-present smartphone measures For each participant, we also calculated timestamped co-present smartphone measures (see Table 3). More specifically, we calculated smartphone use measures for each retained timestamp where it was indicated that the participant was in the co-presence of the partner during the previous hour. Hence, these measures are more specific, more contextualized, and less general than the previous "average daily smartphone measures". Thus, these timestamped smartphone measures are used as proxies of co-present smartphone use. Again, these measures operationalized (a) "screen time", (b) "sessions" as well as (c) "app events". Screen time now reflects the duration of smartphone use during the previous hour, in a partner's co-presence. Sessions and app events reflect different operationalizations of the frequency of smartphone use during the previous hour in the partner's co-presence, being respectively the amount of smartphone sessions and the amount of app events, over these sessions during the previous co-present hour.

Data analysis strategy

Data cleaning

During the initial stages of data cleaning, we identified that certain decision rules were excessively stringent for our

Table 3 Correlations between timestamped co-present smartphone use measures and average daily smartphone use measures, and the traits from the baseline survey

	M (SD, range)	Screen time	Sessions	App events	FP	SC	RQ	Y	CH
Duration (trait)	1.28 (1.21, 0.06–5.54)	**0.36***	0.12	-0.08	0.21	0.13	-0.06	0.16	-0.01
Sessions (trait)	1.38 (1.24, 0–6.09)	**0.34***	**0.49*****	0.01	0.18	0.15	0.09	-0.01	-0.06
App events (trait)	1.90 (1.43, 0.08–7.73)	0.21	0.12	0.11	0.24	0.15	-0.05	-0.22	-0.02

Note. The (averaged) co-present smartphone use measures are outlined at the row-level. We only look at these variables at the trait level. In the first column, we report the descriptive statistics. Next, we report the correlations of these measures with the daily smartphone use measures and measures of the baseline survey. Actor level correlations were investigated for each smartphone using participant (n = 53), but partner level correlations were not of interest here. The significance levels of the correlations are indicated via with * p <.05, ** p <.01, *** p <.001. (FP = Feeling phubbed, SC = smartphone conflict, RQ = Relationship quality, Y = years of living together, CH = number of children)

specific research focus. This necessitated the consideration of interdependencies among various data types. To effectively navigate this intricate network of dependencies, we meticulously documented each step of the decision-making process (https://bit.ly/3GRrMtq).

Our objective was to align the smartphone logging data of one partner with the experience sampling data of the other, thereby encapsulating the viewpoints of both partners within our longitudinal data structure. This approach enabled us to compute the degree of co-present smartphone usage. Consequently, each row of the dataset comprises dyadic data, meaning each row represents the degree of simultaneous smartphone usage of one partner and whether the other partner expressed any dissatisfaction or conflict regarding that usage at that specific observation moment (refer to Fig. 4). The longitudinal data varies across the rows for the same participant, while the cross-sectional data remains consistent across the rows for the same participant.

Different analytic levels

To address the hypotheses, we analyzed the cross-sectional dyadic data from the baseline survey. More specifically, we tested the hypotheses about the potential influence of feeling phubbed on experienced relationship quality, both directly and mediated via smartphone conflict[4]. Each of these variables was measured once for men, and once for women within each mixed-gender couple. We analyzed the four paths[5] of the dyadic mediation model using the function `sem`, which is part of the "lavaan" package (Rosseel, 2012) in R v4.3.2. To test the significance and the K-ratio, we checked *p*-values, and bootstrapped CI's (see https://bit.ly/3Ng2IzW, 100 repetitions via Monte Carlo method). It offered us 95% CI's. To control for the relationship characteristics and inclusion criteria (Foster Campbell, 2022; Vanden Abeele, 2020), we also tested the same dyadic mediation model with two control variables: the number of years living together and the number of children the couples had at the intake stage.

We performed an exploratory analysis to examine the relationship between one's objective smartphone usage measures and three variables from our hypotheses (feelings of being phubbed, smartphone-related conflict, and relationship quality) within the context of the couple. Actor-level associations refer to the correlations between a user's smartphone variables and their own cross-sectional variables. Partner-level associations, on the other hand, connect a user's smartphone measures with their partner's cross-sectional variables. The lower half of Table 2 shows the associations with the daily average smartphone usage measures. Table 3 shows the associations with the time-stamped co-present smartphone usage measures.

Participant code	Couple code	ESM id	logging id	V1	day	timestamp	answer ESM question	timestamped smartphone use	...
1	1	A	a	3	1	15h30			
1	1	A	a	3	1	20h45			
1	1	A	a	3	2	8h20			
2	1	B	/	4	1	17h34			
3	2	C	c	2	1	7h30			
5	3	E	e	2	1	19h20			
...	...	...	...	...	...	...	...	...	

Fig. 4 Explanation of data structure. *Note.* Each line of data was specified by the participant ID of the ESM reporting participant, and by the couple ID linked to the specific dyad of a couple. Couples were dropped during data cleaning (1) when none of both succeeded in the ESM, (2) when there was not enough smartphone logging data from one of both, or (3) when the data of both did not match in day and time stamp. When a dyad was not dropped by the cleaning steps, data of a dyad could be included once or twice. On the one hand, it was possible that a man from the dyad had enough ESM observations that could be linked with smartphone logs of his wife. The opposite was also possible

[4] Given that the measure "conflict over smartphone use" was operationalized as conflict over *own* smartphone use, we used the partner's mediating variable when testing the relationship between the predictor and the outcome in the actor. That is, whilst testing the predictor using the measure from the male participant, the used mediator was a measure reported by the female partner. Respectively, when the predictor was taken from the female participant, the mediating variable reported by the male partner was used.

[5] Indirect & Total effect 1 (male, actor-level): feeling phubbed$_{male}$ → smartphone conflict$_{female}$ → relationship quality$_{male}$. Indirect & total effect 2 (male, partner-level): feeling phubbed$_{female}$ → smartphone conflict$_{male}$→ relationship quality$_{male}$. Indirect & total effect 3 (female, actor-level): feeling phubbed$_{female}$ → smartphone conflict$_{male}$ → relationship quality$_{female}$. Indirect & total effect 4 (female, partner-level): feeling phubbed$_{male}$ → smartphone conflict$_{female}$ → relationship quality$_{female}$.

Finally, we focused on the longitudinally measured ESM-variables of smartphone frustration and conflict. However, when looking at the distribution variability of these two variables, we see that respectively 47% and 66% of participants *always*– thus, during each co-present ESM observation - indicated that there was no frustration or conflict about the other's smartphone use. As per the preregistration, we aimed to use multilevel modeling to accommodate the interdependence of our nested data, i.e., the different timepoints within each individual. However, the intra-variability of the ESM answers of participants over different timepoints was very low[6]. Hence, we could not conduct the multilevel hypothesis test, as planned in the preregistration (see deviations: https://bit.ly/3GRrMtq).

Our methodology aided a detailed examination of specific dyads to understand how smartphone-induced frustration and conflict permeate daily life in couples. We focused on exceptional cases: couples who reported the highest levels of smartphone-related frustration (dyad case 1 and dyad case 2), and the couple with the highest average screen time (dyad case 3). It is reasonable to anticipate some implications for relationship quality in these couples.

Results

Descriptive statistics

Table 1 shows the descriptive statistics of the cross-sectional variables, examined via the baseline survey. We found that general levels of feeling phubbed were moderate for both husbands and wives *(M* = 3.00, *SD* = 0.89, M_{male}= 3.10, SD_{male}= 0.93, M_{female}= 2.89, SD_{female}= 0.85*)*. The general levels of smartphone conflict were lower *(M* = 2.04, *SD* = 0.80, M_{male}= 2.00, SD_{male}= 0.68, M_{female}= 2.09, SD_{female} = 0.91*)*, while the reported relationship quality was high *(M* = 4.56, *SD* = 0.76, M_{male}= 4.66, SD_{male}= 0.59, M_{female}= 4.52, SD_{female}= 0.90*)*. Furthermore, Table 1 also shows the bivariate correlations between these different variables at actor and partner level. There was a strong positive association of wives' and husbands' "relationship quality" *(r* =.81, *p* <.001*)*.

Feeling phubbed reported by men is significantly correlated at the actor level with relationship quality *(r* = -.47, *p* <.01*)*. Additionally, a significant correlation is found with conflict about own smartphone use, according to women *(r* =.46, *p* <.01*)*. We also found that feeling phubbed by women is linked with conflict about own smartphone use, as per men *(r* =.58, *p* <.001*)*. Hence, the higher the reported feeling phubbed by a partner, the higher reported conflict over own smartphone use by the other partner. No significant associations were found between smartphone conflict and relationship quality.

Mediation analyses: actor-partner interdependence model (H1a-c)

The mediation analyses accounting for actor and partner effects were conducted to test the first hypothesis. The model indices of fit indicate a satisfactory fit: RMSEA = 0.061, SRMR = 0.051, CFI = 0.996, TLI = 0.97 (Byrne, 1994; Hu & Bentler, 1999). With regards to hypothesis H1a, we found that the men's feeling phubbed negatively predicted their reported relationship quality *(actor effect;* pathway X_{male}→ Y_{male}: *B* = -0.24, *p* =.04, 95% CI [-0.56, 0.05]*)*. Although, the direct *partner effect* on the women's relationship satisfaction was not significant *(*pathway X_{male}→ Y_{female}: *B* = -0.36, *p* =.08, 95% CI [-0.78, 0.06]*)*. These significant associations were not found when looking at women's reports of feeling phubbed ($X_{female} \rightarrow Y_{male}$ and $X_{female} \rightarrow Y_{female}$). Further, no significant link was found between smartphone conflict and relationship quality ($M_{female} \rightarrow Y_{male}$, $M_{male} \rightarrow Y_{female}$ as well as $M_{female} \rightarrow Y_{female}$ and $M_{male} \rightarrow Y_{male}$). We partially accept hypothesis H1a, stating that feeling phubbed and smartphone conflict are negatively related to self-reported relationship quality. See Table 4 for results.

In line with hypothesis H1b, we found that actor's feeling phubbed is significantly related to their partner's perceived conflict over smartphone use, applicable for both, men and women (pathway $X_{male} \rightarrow M_{female}$: *B* = 0.43, *p* =.02, 95% CI [0.08, 0.81]; pathway $X_{female} \rightarrow M_{male}$: *B* = 0.47, *p* <.001, 95% CI [0.33, 0.70]). However, within the model including the two control variables, the pathway $X_{male} \rightarrow M_{female}$ was not significant anymore (*B* = 0.36, *p* =.08, 95% CI [-0.14, 0.74]). Within this model, the pathway $X_{female} \rightarrow M_{male}$ was still significant (*B* = 0.44, *p* <.001, 95% CI [0.28, 0.66]). In the model with control variables (Table 5), the years of living together and number of children was more relevant in explaining conflict over smartphone use than perceived phubbing by a partner. Years of living together negatively predicted the conflict over one's own smartphone use, in both, husbands (*B* = -0.06, *p* =.02, 95% CI [-0.11, 0.0.00]) and wives (*B* = -0.11, *p* =.01, 95% CI [-0.24, -0.04]). The number of children predicted positively conflict over smartphone use in men only: *B* = 0.35, *p* =.04, 95% CI [-0.08, 0.69].

Contrary to the developed hypothesis H1c, though, no significant indirect effects were found. Nevertheless, the total effect was significant at the male actor-level (pathway $X_{male} \rightarrow M_{female} \rightarrow Y_{male}$: *B* = -0.30, *p* =.02, 95% CI [-0.62,

[6] When looking at the variances of these variables within each participant, we see that 27 participants had no variability in the variable "smartphone frustration" and 47 participants had no variability in the variable "smartphone conflict".

Table 4 Mediation analysis conducted to test the outlined hypotheses

	B	SE	*p*-value	95% CI
1. Effect on smartphone conflict (M)				
a. $X_{male} \rightarrow M_{female}$	**0.43**	**0.17**	**0.02***	**[0.08, 0.81]**
b. $X_{female} \rightarrow M_{male}$	**0.47**	**0.11**	**< 0.001*****	**[0.33, 0.70]**
2. Effect on relationship quality (Y)				
X → Y				
a. $X_{male} \rightarrow Y_{male}$	**-0.24**	**0.11**	**0.04***	**[-0.56, 0.05]**
b. $X_{female} \rightarrow Y_{male}$	0.08	0.16	0.65	[-0.37, 0.34]
c. $X_{female} \rightarrow Y_{female}$	-0.02	0.23	0.94	[-0.51, 0.47]
d. $X_{male} \rightarrow Y_{female}$	-0.36	0.21	0.12	[-0.78, 0.06]
M → Y				
a. $M_{female} \rightarrow Y_{male}$	-0.13	0.15	0.39	[-0.59, 0.27]
b. $M_{male} \rightarrow Y_{male}$	-0.03	0.15	0.86	[-0.29, 0.34]
c. $M_{male} \rightarrow Y_{female}$	0.09	0.26	0.73	[-0.44, 0.54]
d. $M_{female} \rightarrow Y_{female}$	0.02	0.29	0.95	[-0.60, 0.64]
3. Total Effect				
a. $\mathbf{X_{male}} \rightarrow M_{female} \rightarrow \mathbf{Y_{male}}$	**-0.30**	**0.13**	**0.01****	**[-0.62, -0.10]**
b. $\mathbf{X}_{female} \rightarrow M_{male} \rightarrow \mathbf{Y}_{male}$	0.06	0.12	0.62	[-0.30, 0.33]
c. $\mathbf{X}_{female} \rightarrow M_{male} \rightarrow \mathbf{Y}_{female}$	0.02	0.17	0.89	[-0.33, 0.37]
d. $\mathbf{X_{male}} \rightarrow \mathbf{M_{female}} \rightarrow \mathbf{Y_{female}}$	**-0.35**	**0.17**	**0.04***	**[-0.84, 0.08]**
4. Indirect effects				
a. $X_{male} \rightarrow M_{female} \rightarrow Y_{male}$	-0.06	0.08	0.47	[-0.36, 0.05]
b. $X_{female} \rightarrow M_{male} \rightarrow Y_{male}$	-0.01	0.07	0.86	[-0.13, 0.20]
c. $X_{female} \rightarrow M_{male} \rightarrow Y_{female}$	0.04	0.12	0.74	[-0.23, 0.28]
d. $X_{male} \rightarrow M_{female} \rightarrow Y_{female}$	0.01	0.14	0.95	[-0.38, 0.25]

Note. The k-ratio was calculated for men (absolute value of 0.31, CI [-3.09, 0.77]), but this could not be calculated based on the standardized values of women. Levels of significance: *p <.05, **p <.01, ***p <.001. Keep in mind that "smartphone conflict" refers to "conflict about own smartphone use". This influences the construction of our dyadic model. Indirect & Total effect 1 (man, actor-level): feeling $phubbed_{male}$ → smartphone $conflict_{female}$ → relationship $quality_{male}$. Indirect & total effect 2 (man, partner-level): feeling $phubbed_{female}$ → smartphone $conflict_{male}$→ relationship $quality_{male}$. Indirect & total effect 3 (woman, actor-level): feeling $phubbed_{female}$ → smartphone $conflict_{male}$ → relationship $quality_{female}$. Indirect & total effect 4 (woman, partner-level): feeling $phubbed_{male}$ → smartphone $conflict_{female}$ → relationship $quality_{female}$

-0.10]), but not when checking the confidence interval at the woman partner-level (pathway $X_{male} \rightarrow M_{female} \rightarrow Y_{female}$: B = -0.35, p =.04, 95% CI [-0.84, 0.08]).

Exploratory analysis 1: combining baseline, ESM, and logged variables

Daily average screen time is significantly related to feeling phubbed at the partner level (r =.35, p =.009). Also, daily average screen time is significantly linked with relationship quality at actor level (r = -.68, p <.001) and partner level (r = -.51, p <.001). Although daily average screen time is positively correlated with the average duration of co-present smartphone use (r =.36, p =.01), no significant association was found between this co-present duration and feeling phubbed, or relationship quality.

When looking at the frequency of daily smartphone use, we only found a significant negative association at the actor-level between daily average app events and reported relationship quality (r = -.41, p =.002). Although daily average sessions correlated positively with the averaged amount of co-present sessions (r =.49, p <.001), no significant association was found between average co-present sessions and relationship quality.

When investigating the link between smartphone conflict and objective averaged smartphone use measures, we see that the longer someone uses their smartphone on a daily average, the more conflict over their own smartphone use they report (r =.38, p =.005).

Exploratory analysis 2: outstanding cases of dyads

For a more profound exploration, we selected outstanding couples: those with the highest smartphone frustration reports (*dyad case 1* and *dyad case 2)*, as well as the couple with the highest average screen time (*dyad case 3*).

Dyad case #1

A man in his thirties reported frustration about the smartphone use of his wife (also in her thirties) in 55% of the observations (17 out of 31). The couple has children and have been living together 10 years or less. During the study run, his wife used her smartphone daily on average for 261.32 min, and had a high frequency of use, represented by an average of 372.67 app events and 117.67 sessions each day. Her smartphone use seems to play a role within their relationship, which was reflected in her husband's high evaluation of feeling phubbed (4.00, and the wife reported a moderate amount of conflict about her smartphone use: 3.67). Both perceived their relationship quality to be average (husband = 3.00, wife = 2.60). The wife reported that she did not experience frustration over the husband's smartphone use, whose daily use averaged for 228.84 min, over 100.07 app events and 43.38 smartphone sessions. The husband reported rare conflict about his smartphone use (1.67), whilst his wife reported rarely feeling phubbed (1.88).

Dyad case #2

A woman in her forties reported frustration about the smartphone use of her husband (also in his forties) half of the time (13 out of 26 events). They have children and have been

Table 5 Mediation analysis with control variables, conducted to test the outlined hypotheses

	B	SE	*p*-value	95% CI
1. Effect on smartphone conflict (M)				
a. $X_{male} \rightarrow M_{female}$	*0.36*	*0.20*	*0.08*	*[-0.14, 0.74]*
b. $X_{female} \rightarrow M_{male}$	**0.44**	**0.10**	**< 0.001*** **	**[0.28, 0.66]**
c. $C_{years\ together} \rightarrow M_{female}$	**-0.11**	**0.04**	**0.01****	**[-0.24, -0.04]**
d. $C_{amount\ of\ children} \rightarrow M_{female}$	0.12	0.32	0.70	[-0.64, 0.79]
e. $C_{years\ together} \rightarrow M_{male}$	**-0.06**	**0.02**	**0.02***	**[-0.11, 0.00]**
f. $C_{amount\ of\ children} \rightarrow M_{male}$	**0.35**	**0.17**	**0.04***	**[-0.08, 0.69]**
2. Effect on relationship quality (Y)				
X → Y				
a. $X_{male} \rightarrow Y_{male}$	**-0.26**	**0.12**	**0.03***	**[-0.46, 0.10]**
b. $X_{female} \rightarrow Y_{male}$	0.13	0.15	0.41	[-0.32, 0.42]
c. $X_{female} \rightarrow Y_{female}$	0.04	0.28	0.90	[-0.55, 0.83]
d. $X_{male} \rightarrow Y_{female}$	-0.37	0.20	0.07	[-0.84, -0.00]
e. $C_{years\ together} \rightarrow X_{female}$	-0.35	0.49	0.47	[-1.40, 0.77]
f. $C_{amount\ of\ children} \rightarrow X_{female}$	-0.02	0.06	0.77	[-0.14, 0.12]
g. $C_{years\ together} \rightarrow X_{male}$	-0.67	0.49	0.17	[-1.78 0.21]
h. $C_{amount\ of\ children} \rightarrow X_{male}$	0.05	0.05	0.30	[-0.02, 0.19]
M → Y				
a. $M_{female} \rightarrow Y_{male}$	-0.14	0.16	0.39	[-0.52, 0.14]
b. $M_{male} \rightarrow Y_{male}$	-0.11	0.18	0.53	[-0.46, 0.33]
c. $M_{male} \rightarrow Y_{female}$	-0.01	0.32	0.99	[-0.65, 0.74]
d. $M_{female} \rightarrow Y_{female}$	0.02	0.28	0.94	[-0.46, 0.64]
e. $C_{years\ together} \rightarrow Y_{female}$	0.01	0.05	0.99	[-0.20, 0.09]
f. $C_{amount\ of\ children} \rightarrow Y_{female}$	0.46	0.38	0.23	[-0.17, 1.54]
g. $C_{years\ together} \rightarrow Y_{male}$	-0.01	0.03	0.90	[-0.12, 0.05]
h. $C_{amount\ of\ children} \rightarrow Y_{male}$	0.40	0.22	0.06	[0.00, 1.08]
3. Total Effect				
a. $\mathbf{X_{male}} \rightarrow M_{female} \rightarrow \mathbf{Y_{male}}$	**-0.30**	**0.14**	**0.03***	**[-0.55, -0.09]**
b. $\mathbf{X}_{female} \rightarrow M_{male} \rightarrow \mathbf{Y}_{male}$	0.07	0.11	0.67	[-0.21, 0.31]
c. $\mathbf{X}_{female} \rightarrow M_{male} \rightarrow \mathbf{Y}_{female}$	0.04	0.21	0.86	[-0.48, 0.49]
d. $\mathbf{X}_{male} \rightarrow M_{female} \rightarrow \mathbf{Y}_{female}$	-0.36	0.21	0.08	[-0.82, 0.11]
4. Indirect effects				
a. $X_{male} \rightarrow M_{female} \rightarrow Y_{male}$	-0.05	0.08	0.56	[-0.34, 0.05]
b. $X_{female} \rightarrow M_{male} \rightarrow Y_{male}$	-0.05	0.09	0.57	[-0.22, 0.19]
c. $X_{female} \rightarrow M_{male} \rightarrow Y_{female}$	-0.01	0.16	0.99	[-0.36, 0.38]
d. $X_{male} \rightarrow M_{female} \rightarrow Y_{female}$	0.01	0.11	0.95	[-0.26, 0.29]

Note. The k-ratio was calculated for men (absolute value of 0.49, CI [-4.85, 0.84]), but this could not be calculated based on the standardized values of women. Levels of significance: *p <.05, **p <.01, ***p <.001. In italic we've printed the associations that were not significant anymore when adding the two control variables. Keep in mind that "smartphone conflict" refers to "conflict about own smartphone use". This influences the construction of our dyadic model. Indirect & Total effect 1 (men, actor-level): feeling $phubbed_{male}$ → $smartphone\ conflict_{female}$ → $relationship\ quality_{male}$. Indirect & total effect 2 (men, partner-level): feeling $phubbed_{female}$ → $smartphone\ conflict_{male}$→ $relationship\ quality_{male}$. Indirect & total effect 3 (women, actor-level): feeling $phubbed_{female}$ → $smartphone\ conflict_{male}$ → $relationship\ quality_{female}$. Indirect & total effect 4 (women, partner-level): feeling $phubbed_{male}$ → $smartphone\ conflict_{female}$ → $relationship\ quality_{female}$

living together for 10 years or less. The man uses his smartphone more than his wife (on average 185.11 min screen time compared to 89.90 min of his wife; 202.62 app events for him, compared to 92.07 app events for her). Although the wife reported frustration related to the smartphone use of her partner on half the occasions, her partner reported low rates of conflict over his smartphone use (2.00). Both partners reported very high perceived relationship quality (woman = 5.00, man = 4.20). In addition, the wife reported low perceived partner phubbing (1.88), contrary to the husband who feels frequently phubbed (5.00). However, the man indicated during none of the observations that he was frustrated with her smartphone use, and she also reported hardly any conflict over her smartphone use (1.33).

Dyad case #3

Finally, a close inspection of a woman in her thirties with a man (also in his thirties) revealed that while he has the highest average daily screen time of all participants (274.44 min a day), she did not report any smartphone frustration during their co-present observations. The partners have been living together for more than 10 years and have children. Both reported the highest perceived relationship quality score (5.00). Although her partner used the smartphone for 274.44 min a day and during 313.76 smartphone sessions in the study run, this participant never reported any smartphone-related frustration. However, during the hour before asking about frustration the man used his smartphone on average for 15 minutes and unlocked and locked his smartphone during 23 smartphone sessions. Again, we see that frustration reports are not clearly linked with objective smartphone use. Both partners, however, reported

occasional feeling phubbed (husband = 3.88, wife = 3.75) and conflict over one another's smartphone use (husband = 2.67, wife = 2.33).

Discussion

Studies have recently begun exploring how smartphone use can spill over personal life and influence interpersonal dynamics. In our study, we attempted to overcome several methodological shortcomings related to the research on "partner phubbing". Through the combination of experience sampling and smartphone logging, we addressed overreliance on cross-sectional measures at a single time point, exploration of the perspective of only one partner, and lack of objective smartphone use measures. The actor-partner interdependence model only partially supported our hypotheses, showing differences between men and women. After combining baseline, ESM, and logged data, we found no association between co-present smartphone use, feeling phubbed, and relationship quality, although the link between own smartphone use duration and conflict over own smartphone use was significant.

Hypothesis testing: the actor-partner interdependence model

The mediation analyses revealed that men reported relationship quality decreased when they felt phubbed due to their partner's smartphone use, but this was not found in women. This result supports the recent findings of Leitao et al. (2024), who reported that the negative impact of phone use on social connectedness was more prevalent in men than in women, the effect being three times as large in the former. The difference was not found when participants did not have their phones, although it is worth noting that the participants were not intimate partners but strangers. In our study, though, the score of women feeling phubbed was lower than the score for men, and did not correlate with either women's or men's relationship quality. This somewhat surprising finding could be attributed to several factors. For instance, the role of social norms and gender roles: when wives phub their husbands, the latter may perceive it as a break of marital rules, leading to lower satisfaction, but not in reverse, as societal norms may be more lenient towards husbands' behaviors. Alternatively, we suggest that wives may be more forgiving and associate husbands' phone use with external factors (e.g., work, stress) rather than neglect, whereas husbands may attribute their wives' phone use to negative intentions. Other studies do not provide a clear answer to the role of gender in partner phubbing and relationship satisfaction, either. Booth et al. (2021), like in the current study, found that women's self-reported technoference explained worse relationship outcomes in their husbands. Similarly, Chen et al. (2021) found that women's phubbing behavior had a greater impact on relationship quality than husbands' phubbing. These results suggest that perceptions of phubbing and its impact may differ for men and women, but also may also depend on whether participants report their own or perceived phubbing by partner.

Furthermore, no significant association was found between smartphone conflict and relationship quality, neither for men, nor for women. However, a significant relationship was found between an individual feeling phubbed, and their partner's perceived smartphone use conflict, for both genders. Despite the lack of significant indirect effects, the overall effect was significant for both, men and women. The findings of the mediation analyses refute the findings of previous studies to some extent. The direct link between phubbing and relationship quality has been previously reported in empirical studies (Hipp & Carlson, 2021). However, the conflict over smartphone use was not a significant mediator between feeling phubbed and relationship quality. This contradicts findings from previous studies, where other conflict over smartphone use and proxy variables mediated the link between phubbing and relationship satisfaction (for example Beukeboom & Pollmann, 2021; Roberts & David, 2016).

The addition of control variables revealed new information that requires its discussion within the framework of relationship dynamics. First, years of living together reduced conflict over own smartphone use in husbands and wives. We may debate whether this may have to do with the notion that over time, as the relationship becomes more and more grounded, partners are able to establish implicit rules around technology use in the household (Foster Campbell, 2022). In such a way, intimate partners negotiate and co-regulate each other's smartphone use to reduce relational harm (Vanden Abeele, 2020). Previous studies have demonstrated that establishing rules may be a successful strategy for conflict management, and when such rules are violated, couples may reframe them to suit their future interactions, which is necessarily explicable by relationship duration and living together (Foster Campbell, 2022). On the other hand, the number of children increased conflict over their own smartphone use in men participants only. To explain this unexpected finding, we borrow from existing studies on gender differences and smartphone presence. Fathers may experience work-related stress and time constraints due to their traditional roles as providers, as research shows (Gritti et al., 2023). The presence of more children could exacerbate this stress, leading to heightened conflict when fathers engage in smartphone use (which might be perceived as a distraction or even a neglect of family studies,

due to their already limited time spent with children; see Busch & McCathy, 2021). Mothers, on the other hand, may be perceived as more adept at multitasking (and are often perceived as such, see Mäntylä, 2013), whereas fathers may feel pressure to be more present and engage in parenting.

Objective smartphone use measures

By linking the cross-sectional baseline measures with objective smartphone use measures, we found an association between one's average daily screen time and the other's reported relationship quality, as well as with feeling phubbed. One plausible explanation is that higher screen time reflects a pattern of withdrawn attention and responsiveness on the part of the smartphone user towards their partner (see Frackowiak et al., 2022; Thomas et al., 2022), as screen time inevitably overlaps with the time partners spend together. Therefore, the degree to which smartphone use results in decreased attention and responsiveness could influence feelings of being ignored and deteriorate relationship quality. The peculiarity of the daily screen time is not to be neglected, as it encompasses *all* device usage, including social media, entertainment, work-related tasks, and could also extend to "phubbing", as the correlation indicates. In this case we could debate that the use of smartphones can "take away" the quality time that the partners spend together. However, note that while the daily screen time was objectively measured, it does not capture the quality of interactions, but indicates the general prevalence of smartphone's presence in the relationship.

On the other hand, the average daily smartphone use frequency seems to differ from the average daily screen time, which could be more informative of the interaction dynamics. Frequency may primarily indicate the act of switching back and forth between the smartphone and other activities, and this can go more easily unnoticed (for example *task switching*), compared to screen time attracting others' attention and responsiveness. For instance, one partner's daily screen time may be higher due to the shared use of the device with the other partner, for instance, to watch movies or digital content. This is to be distinguished from the smartphone use frequency, as it provides a different type of contextual information. Upon the investigation of the ESM data, we conclude that smartphone frustration and conflict are not as prominent in couples' micro-environments, as expected. This is in line with McDaniel and Drouin (2019), who found that only in 15% of the observations someone reported that the cellphone was interrupting their interaction. We conclude that potential interruptions, frustrations, and conflicts due to smartphone use occur less frequently than expected.

The use of timestamped indicators of co-present phone use showed no correlation with feeling phubbed or relationship quality (Table 3). We argue that whilst they may be informative of general patterns of phone use in a partner's presence, there may not necessarily be covariance between those patterns and relational outcomes. Furthermore, we may speculate about the nature of 'feeling phubbed' as something that is specific to the interpretation of a partner's behavior rather than the duration of phone use itself (see Reis et al., 2004).

Outstanding dyad case analysis

The initial data exploration prompted us to investigate three specific dyads. The detailed exploration of the individual scores reported within each couple revealed incongruencies, especially when exploring smartphone frustration. A closer examination of the three outstanding dyads individually, provided us with information that could not be obtained via a statistical analysis using the complete sample. It shed some light on intra-couple incoherence, for instance, a participant experiencing a lot of co-present smartphone use by partner but reporting no frustration or conflict over their use of device. We noticed in our analysis that spouse's phone use might lead to misunderstandings or emotional distance, hence, significantly impact the relationship. To address some of the unexpected findings, we argue that the lack of feeling phubbed could be due to the spouse's own smartphone habits or the couple's overall communication quality. It highlights that individual tolerance for phone use varies, and satisfaction is not solely tied to usage levels. On the other hand, occasional feeling phubbed and moderate conflict suggest that both partners experience some tension related to phone use. Their long relationship duration may contribute to their ability to manage these conflicts effectively. We cannot, however, draw an unambiguous conclusion from these findings, especially when it may partially contradict the results of the mediation analysis. We can debate whether certain couples have managed to successfully integrate the use of mobile phone use into their interactions in a way that does not interfere with their interpersonal dynamics, a notion rarely explored in the literature (Kelly & Miller-Ott, 2022).

Given the omnipresent role smartphones play in couples' daily lives, it becomes imperative to evaluate the role of smartphones for each couple within their unique contexts, recognizing the variability that exists among individuals and within couples. For instance, recent research has brought up the notion of "implicit rules" around technology use that develop naturally over time, in the form of unsaid expectations, or a contract that both partners implicitly follow (Foster Campbell, 2022). Whilst this may allow us to

comprehend the nature of our results, this is merely a speculation that requires further empirical scrutiny. Adding qualitative methods to our existing methodology can contribute to achieving this.

Arguably, this could be indicative of the person-centered (or, in this case, couple-centered) paradigm in which the establishment of general laws in social science is replaced by an in-depth case-by-case investigation of research subjects. This argument complements the recent calls from researchers to explore the function of smartphone use and people's subjective perceptions and sense making of the impact smartphone use has on their interpersonal relationships (Cummings & Reimer, 2021; Salmela et al., 2019).

Implications

The present study goes beyond existing research conventions by mixing subjective reports from participants, and unbiased smartphone use measures. More specifically, our operationalization of co-present smartphone use provides more refined measures compared to the average smartphone use measures (Denecker et al., 2023). While the latter encompasses smartphone usage across various contexts throughout the day, co-present smartphone use specifically captures smartphone use during partner interactions. This operationalization allowed us to estimate whether partners were in each other's presence, and to match the corresponding objective measures of smartphone use through logged variables. This approach may serve as a methodological expansion in future research avenues, as it considers the complex interplay between how partners navigate their time together and how they integrated the technology use in their interactions.

In our study, we recruited couples who had at least one child between the ages of 4-10 and who had been cohabiting, to fulfill the inclusion criteria of a larger project. Age is a valuable factor in this study, as most prior research focused on couples under 35 years old. Additionally, the average relationship duration, which was 11 years, is also significant. Arguably, partners who have been exposed to each other's behaviors, including simultaneous smartphone use, for over a decade, might have adjusted their smartphone usage patterns over the course of their relationship, set boundaries, and co-regulated expectations of each other's behavior (for example, see Salmela et al., 2019). This could potentially account for the minimal reported conflict over smartphone use and low levels of frustration.

The exploration of three specific dyads allowed us to deepen our understanding of smartphone use trends based on sociodemographic and relationship data provided by the partners. The combination of experience sampling and smartphone logging offered us the opportunity to zoom-in on daily processes in participants' micro-environments, to acknowledge the uniqueness of each couple participating in our study. We argue that the exploration of the three dyads highlights individual perceptions and coping mechanisms: understanding each partner's needs and boundaries regarding smartphone use is crucial. Some people may feel comfortable with frequent phone use, while others may find it disruptive, especially when it indicates how partners prioritize the individual smartphone-related activities versus relationship ones. This dyad-centred approach is not widely practiced in psychological research, but we argue it beneficial for future explorations and interventions, in order to optimise the use of mobile phone in each other's presence, so that it is the most beneficial and harmless to the relational wellbeing (Frackowiak et al., 2024a, b).

It is pertinent to contextualize the current study within the existing theoretical frameworks. Vanden Abeele's (2020) Attention-Arousal-Attribution Framework proposed that partners may gradually develop behavioral norms with time, and as such, co-present phone use may become less harmless over time. In the study, controlling for the number of years together was found to reduce conflict over own smartphone use in both, wives and husbands. This suggests that over time, partners may develop coping strategies that reduce or mitigate the negative impact of phone use in interactions, in line with the theory. Cummings and Reimer (2021) postulated in The Cellphone Relevance Hypothesis that the function the mobile device plays in interactions defines how the use of it is evaluated by the interlocutors (i.e., positive if it is integral to the interaction, negative if it is incidental and not related). And whilst this study did not control for the function of smartphone use, we debate that it may explain the notable variability across participants and across couples, and why the time spent using one's mobile phone was not necessarily associated with feeling phubbed or lower relationship quality.

Limitations

Several limitations of our study need to be considered. First, our participants reported high perceived relationship quality. A plausible rationale would be that couples with high relationship quality may be more inclined to participate in research. This can also be due to the inclusion criteria of this study, where couples needed to have at least one child between the ages of 4-10 years old and who had been cohabiting. This may also have an influence on participants' emotional quality. Given that having children introduces stressors, couples with high relationship quality may handle those and other stressors better. Altogether, this may suggest a biased sample and raise questions about the generalizability of our results. Future studies may benefit from

strategies to recruit couples who are not fully satisfied with their relationships, as the role of the partners' smartphone use may be a more decisive factor in explaining their poor relationship welfare.

While the small sample size and poor model fit prompt us to suggest interpreting the reported analyses with caution, we argue that the sample size did not impact the outstanding dyad case analysis, as we only explored the descriptive information of these specific dyads. However, the use of the Android-only logging application resulted in the exclusion of users of other operating systems. We acknowledge that this is a serious limitation given that one should not dismiss the large proportion of the population that uses Apple smartphones (Afzal, 2023). Hence, we suggest optimizing the existing research tools used for recording smartphone logs, so that they do not exclude Apple users or other operating systems, because their patterns of phone use are not to be neglected.

Finally, it is essential to acknowledge that our measures of co-present smartphone use are proxies. Participants only had to indicate whether their partner was present during the previous hour, without specifying the quantitative and qualitative characteristics of their time together. In line with The Cellphone Relevance Theory (Cummings & Reimer, 2021), we argue it is relevant to explore the contextual features surrounding the smartphone presence in interactions. Hence, we propose that the future research explores not only the frequency and length of smartphone use, but also its *function* within the dyadic interaction, to get the most accurate assessment of the device's role and why it may be perceived as harmful or harmless.

Recommendations for future research

We argue that future research should rely on multiple sources of data collection, especially when at least one source of data can provide objective measures and reduce participant bias. One of the alternative ideas would be to change the fixed ESM notification scheme to randomized, to also gain insights into moments where partners are not together. In these "not together" ESM surveys, participants can be asked to report whether they were digitally in contact with their partner during the previous hour. Hence, it is possible to study the role of technology in remaining connected, despite not physically together.

Additionally, it would also be pertinent to extend the focus to entire households, including children. The combined methodology would allow one to capture whether the participant had been spending time alone, with their partner or with their child, or in a combined presence of both. This classification would be useful in providing more insights about different interpersonal dynamics at play within a broader household context.

Conclusions

Our study used a comprehensive methodology, combining a cross-sectional survey, experience sampling and smartphone logging in collecting dyadic data, to reveal nuanced insights into smartphone use within couples' interactions. We found that the link between feeling phubbed and relationship quality was only significant for men. Furthermore, we found a link between average daily screen time, with feeling phubbed and reported relationship quality. Surprisingly, we also found a low occurrence of smartphone frustration and conflict in couples' daily lives. We recommend that future research incorporate qualitative methods, such as observational studies and in-depth interviews. This can improve the understanding of the complex dynamics of smartphone use within couples, recognizing the variability among individuals and relationships.

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Data availability The anonymized dataset can be found on OSF (file "total_wth_9"; https://bit.ly/3Ng2IzW). The dataset is the product of merging and cleaning (see the specific steps described in the file "annotated-total-script.html"). It was also used to develop Tables 1, 2, and 3 of the present manuscript. Furthermore, the dataset and the script used to develop Tables 4, and 5, outlining the results of the bootstrapped mediation analysis are also available (files "mediation_data_7_11.Rda" and "Mediation_analysis.Rmd", respectively).

Declarations

Ethical statement The study protocol was approved by the Ethics Committee of the Faculty of Political and Social Sciences of Ghent University. The acceptance letter signed by the Committee is available upon request. The Authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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