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Daily smartphone use predicts parent depressive symptoms, but parents' perceptions of responsiveness to their child moderate this effect

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Introduction: Smartphone use during caregiving has become increasingly common, especially around infants and very young children, and this use around young children has been linked with lower quality and quantity of parent-child interaction, with potential implications for child behavior, and parent-child attachment. To understand drivers and consequences of parent phone use, we were interested in the daily associations between parent phone use and depressed mood, as well as the potential for parent perceptions of their responsiveness toward their infant to alter the association between parent phone use and mood.

Methods: In the present study, we explored associations between day-to-day changes in parent smartphone use (objectively-measured via passive sensing) around their infant, depressed mood, and parent perceptions of their responsiveness to their infants among a sample of 264 parents across 8 days. We utilized multilevel modeling to examine these within-person daily associations.

Results: Objectively-measured parent smartphone use during time around their infant was significantly associated with depressed mood on a daily basis. Interestingly, this was not true on days when parents perceived themselves to be more responsive to their infant.

Discussion: These results suggest that parent judgements and perceptions of their parenting behavior may impact the potential link between parent phone use and parent mood. This is the first study utilizing intensive daily data to examine how parent perceptions may alter the felt effects of phone use on their parenting. Future work examining potential impacts of smartphone use on parenting should consider the effects of both actual use and perceptions about that use.

KEYWORDS

smartphone use, parenting, parent responsiveness, caregiving, depression, technofence, phubbing, phone tracking

Introduction

Smartphone use during caregiving has become increasingly common, especially around infants and very young children (Knitter and Zemp, 2020; Braune-Krickau et al., 2021). According to the Pew Research Center, more than half of parents (56%) felt they spend too much time on their smartphone, while about 68% reported being distracted by their phone when spending time with their children (Auxier et al., 2020). Research suggests that about 42%–72% of parents report that technology sometimes interferes

with parenting activities, such as mealtime, playtime, bedtimes, and so forth (Radesky et al., 2018; Newsham et al., 2020), and phone tracking studies show that parents spend on average 27% of their time around their infant on their smartphone (McDaniel et al., 2023). Phone use specifically during the infant feeding context is also prominent, with most mothers reporting engaging in this use (Ventura et al., 2020; Coyne et al., 2022).

Parent smartphone use around young children has been linked with lower quality and quantity of parent-child interaction, with potential implications for child behavior and parent-child attachment (see McDaniel, 2019 for a review). Among adolescents, heavier parent social media use has been linked with worse teen mental health (Coyne et al., 2023) and many children and adolescents report wanting their parents to reduce media use during family times (Steiner-Adair and Barker, 2014). Therefore, helping parents develop balanced relationships with digital media from infancy through adolescence has been a goal of organizations such as the American Academy of Pediatrics (Hill et al., 2016).

In the present study, we explore associations between day-to-day changes in parent smartphone use, depressed mood, and parent perceptions of their responsiveness to their infants. Drivers of parent phone use around young children include connecting with others, fulfilling parenting needs, getting a break from caregiving duties, and relieving stress (Radesky et al., 2016; Kushlev and Dunn, 2019; McDaniel, 2019; Torres et al., 2021; Wolfers, 2021). In qualitative work, parents describe using smartphones as a mood regulation strategy that allows them to both escape distressing interactions with children and access entertaining content. Yet, at the same time, these parents report that smartphones can be a source of stress from information overload, receiving unwanted social contact, seeing upsetting content on social media, and more (e.g., Radesky et al., 2016; Torres et al., 2021; Wolfers and Schneider, 2021). Therefore, day-to-day changes in mood deserve further exploration as both a driver of, and effect from, parent smartphone use.

We chose to focus our study on infancy, a time period in which parents experience higher rates of depression symptoms, which is known to impact responsiveness to infants and young children (Bernard et al., 2018) and could potentially be exacerbated by heavier phone use. Several studies have documented that smartphone use can create disruptions or distractions during caregiving (Myruski et al., 2018; McDaniel, 2019; Dragan et al., 2021) and infant feeding (e.g., Nomkin and Gordon, 2021), in part due to lower parent responsiveness to child social cues when they are looking at their phone (Vanden Abeele et al., 2020; Braune-Krickau et al., 2021). Responsiveness is particularly important in infancy where the foundations for parent-child attachment begin (Ainsworth et al., 1974; Raval et al., 2001; Boldt et al., 2020). Parental responsiveness has been measured directly in laboratory and naturalistic settings, in which parent-child interactions are observed (Radesky et al., 2014, 2015; Hiniker et al., 2015; Abels et al., 2018; Kushlev and Dunn, 2019; Vanden Abeele et al., 2020). However, in this study, to facilitate intensive daily collection of parent behaviors throughout their everyday life, we measured *perceptions* of parental responsiveness rather than

an objective measure. Though perceptions and behavior may not always match, we were interested in whether perceptions (i.e., parents' feelings/cognitions about their parenting) may influence the daily association between parent phone use and their mood. This builds upon prior work showing links between parent perceptions of responsiveness and their phone use (Braune-Krickau et al., 2021; Mikić and Klein, 2022). Further examination of the links between parent mood, smartphone use, and perceptions of parenting responsiveness is needed to yield insights into potential intervention points to support parents in more balanced media use.

Smartphone use and parent mood

In general, research has indicated that intense and frequent phone usage patterns can be associated with worse mental health, higher depression symptoms, and lower wellbeing (Elhai et al., 2017; Rozgonjuk et al., 2018; Braune-Krickau et al., 2021; Kong et al., 2021). In parents specifically, higher global ratings of depression symptoms have been positively associated with more phone use around children as well as parent-reported preoccupation with phone use and trouble staying away from smartphones during time with children (Newsham et al., 2020; McDaniel, 2021). Potential drivers for this association include using a phone as a coping mechanism (Fei et al., 2023; Hood et al., 2023; Swit et al., 2023; Wolfers et al., 2023a,b) or to seek an escape from negative emotions (Roberts et al., 2022). On the other hand, as noted above, the act of smartphone use may also contribute to heightened negative emotions (Radesky et al., 2016; McDaniel, 2019) due to exposure to negative news, social comparison, or lack of sleep. For example, passive social media use and mindless scrolling have been linked to negative mood and depression symptoms in adults (Hoffner and Lee, 2015; Scott et al., 2017). Indeed, smartphone use can also lead to negative social comparisons, feelings of wasted time, and fear of missing out (e.g., Sagioglou and Greitemeyer, 2014; Coyne et al., 2017), with subsequent links with dissatisfaction with parenting, negative mood, and worse self-perceptions (Amaro et al., 2019; Burnell et al., 2019; Wang et al., 2020; Kirkpatrick and Lee, 2022). Additionally, phone use in certain contexts, such as around parents' bedtime, can lead to worse sleep and increased negative mood (Exelmans and Van Den Bulck, 2016; Lastella et al., 2020; McDaniel et al., 2022b). In other words, smartphone use and mood are bidirectionally linked (e.g., Jun, 2016; Cui et al., 2021; Zhang et al., 2023), with distinct mechanisms driving different directions of associations.

Given the immediacy of these drivers and effects of phone use, we propose that there likely are day-to-day associations between depression symptoms and parent smartphone use. However, prior studies have often examined this topic using global self-reported mood, comparing parents with higher vs. lower smartphone or social media use. Conducting within-parent comparisons of day-to-day changes in mood and smartphone use both helps reduce between-person confounding and may elucidate mechanisms within the context of families' everyday lives.

Smartphone use and parent responsive behavior

Infancy is a critical period for the formation of attachment relationships between parents and infants as well as for the development of various emotion regulation processes (Eisenberg et al., 1998; Boldt et al., 2020; Berona et al., 2023). The caregiving environment, which parents create for their child via their activities and interactions, often plays an important role in this development (Wu and Feng, 2020; Dragan et al., 2021; Bornstein and Tamis-LeMonda, 2022). A vast body of literature focuses on parent-infant interactions and has shown that responsiveness, sensitivity, and interactional synchrony are critical for the child's cognitive, social, and emotional development (Harrist and Waugh, 2002; McFarland et al., 2019), as well as the bond formed between parent and infant (Ainsworth et al., 1974; Boldt et al., 2020). Infants often rely on their parents to assist them with the co-regulation of their emotions, especially during early infancy (Aureli et al., 2018; Buhler-Wassmann and Hibel, 2021). As infants cue for and receive responses from their parents, they begin to set up their internal representations of what the parent-child relationship (and perhaps future relationships) should look like; if parents are generally responsive to their cues and needs in a sensitive manner (i.e., responding warmly, in a timely manner, and contingent to child needs), infants will form a secure attachment relationship with their parent (Ainsworth et al., 1974; Crandell et al., 1997; Raval et al., 2001; Mesman, 2021).

Several studies have examined how parents respond to their child when using their phone and have found that parents are less likely to respond or pay attention to their child during phone use (Abels et al., 2018; Kushlev and Dunn, 2019; Vanden Abeele et al., 2020). For example, Hiniker et al. (2015) found that 56% of caregivers at a playground were distracted by their phone and therefore less responsive to their child (i.e., did not acknowledge their child's bid for attention and remained on their smartphone). Another naturalistic observation study of 53 parent-child dyads further supported these findings as parents on their smartphones were found to respond significantly less to their child in a waiting room and playground environment (Vanden Abeele et al., 2020). Similarly, observational data from Radesky et al. (2014) at fast-food restaurants found that parents whose attention was highly absorbed in their phone took longer to respond to child bids for attention. Lastly, greater smartphone use was related to less encouragement from caregivers to children (Radesky et al., 2015). Various experimental studies also highlight how higher levels of phone use could precipitate less parent responsiveness. For example, a study that assessed parental digital media use during infant feeding found that caregivers were less sensitive when using a tablet as compared to listening to classical music (Ventura et al., 2019), and Porter et al. (2024) found that parent eye contact and vocalizations with their toddler decreased during parent phone use.

As a response to parent smartphone use, infants and very young children tend to react with increased negative affect and fussiness as shown in experiments and naturalistic observations (Elias et al., 2021; Rozenblatt-Perkal et al., 2022). For example, in a naturalistic study on playgrounds and restaurants, it was found that when parents demonstrated low levels of emotional support due

to device use, their children reacted with externalizing symptoms such as frustration and disappointment (Elias et al., 2021). Other negative outcomes extend to infants as reported in Rozenblatt-Perkal et al. (2022) experimental study which examined phone use in parent-infant interactions. Findings suggest that infants exposed to parent phone use experienced negative affect and increased heart rate as compared to lower symptoms of reactivity among infants who engaged in undisrupted play (Rozenblatt-Perkal et al., 2022). Furthermore, Porter et al. (2024) also found an increase in infant heart rate, vagal withdrawal, and a decrease in infant positive affect during parent phone use.

Experimental and observational work has also suggested that parent smartphone use contributes to difficulty with soothing and repairing their connection with their infant. For example, an increase in infant negative affect during parent smartphone use was found in Myruski's Still Face experimental study, and parents who had heavier smartphone usage habits had more difficulty with the co-regulatory "reunion" phase of the experiment (Myruski et al., 2018). Another still-face experiment found that parental smartphone use was associated with greater infant-self comforting behavior (Stockdale et al., 2020). Thus, we see that parent responsiveness often decreases during parent phone use and infants and children notice and may react to this use and distraction. Although effects on attachment have yet to be thoroughly tested, these changes may lead to lower quality parent-infant bonds and attachment relationships over time, at least if phone distraction occurs frequently (e.g., McDaniel, 2019). Therefore, phone use may be a modifiable factor in shaping parent-infant interactions during the perinatal or infancy period.

Parent perceived responsiveness, smartphone use, and daily mood

Links between smartphone use (both during caregiving in general and during infant feeding) and daily mood are not likely to be the same on all days or for all parents. Indeed, theoretical models of media effects (Valkenburg and Peter, 2013) and recent research in adolescents (Beyens et al., 2020) suggest that subsets of individuals are more likely to experience changes in mood with their media use. Parents with higher parenting self-efficacy (e.g., who perceive they are more effective in their parenting) on a given day or those who are generally more responsive to their infants might not experience as much distress from fluctuations in their smartphone use. On the other hand, parents may feel more dissatisfaction on days when they perceive they pay more attention to their smartphones than their infants. Smartphones, by their nature, demand attention, which can lead parents to sometimes feel a sense of detachment from their immediate surroundings (Reed et al., 2017; McDaniel, 2019; Lemish et al., 2020). Consequently, parents may perceive themselves to be more distracted, less emotionally available to their children, less attuned to their child's needs, and not meeting their own expectations for quality of parenting (Kildare and Middlemiss, 2017; McDaniel and Radesky, 2018; McDaniel, 2019; Vanden Abeele et al., 2020; Braune-Krickau et al., 2021). Indeed, many parents express feeling guilty

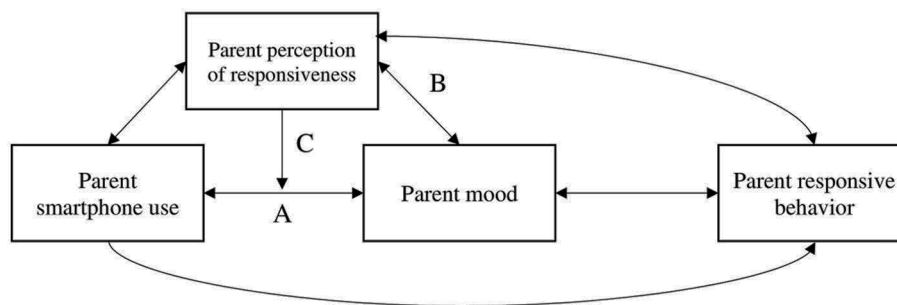


FIGURE 1

Conceptual model of the complex connections between parent smartphone use, perceptions of responsiveness, mood, and actual parent behavior. In the current study, we focus on paths A and B, as well as the moderation of path A by perceptions of responsiveness (path C).

about their phone use around their child (Wolfers et al., 2023a), which for many translates into a desire to change aspects of their phone use (McDaniel et al., 2023).

Conversely, when parents perceive they have been highly responsive to their infants (i.e. responding to crying, facial expressions, etc.), positive mood often follows and contributes to a strong emotional attachment between the child and caregiver (Malatesta et al., 1989; World Health Organization, 2004). This positive emotional state may reinforce the perception of responsive caregiving, creating a cycle wherein perceived responsiveness is linked with positive mood. On the other hand, when parents perceive themselves as less responsive, negative mood may emerge (Eisenberg et al., 1991; Shipman and Zeman, 2001).

Thus, we propose the following conceptual model (see Figure 1), which illustrates the many possibilities of how parent smartphone use, perceptions of responsiveness, mood, and actual parent behavior can be connected. In the current study, we focus on daily within-parent associations between smartphone use and parent mood (path A) and daily within-parent perceptions of responsiveness and parent mood (path B). In addition to these daily within-person associations, we also seek to examine how parental self-reported perception of responsiveness to their infant moderates associations between daily fluctuations in depression symptoms and smartphone use (path C).

Current study

In this study, we utilized parent self-reports and passively tracked smartphone use across 8 days to examine daily associations between depressed mood, objectively-measured smartphone use around their infant, and perceptions of parents' responsiveness to their infant. We explored both phone use around infant in general (i.e., times when physically near infant or playing with infant) and phone use during infant feedings. Thus, we asked the following:

- RQ1: Is parent smartphone use around their infant associated with daily depressed mood?

- RQ2: Is parent perception of responsiveness to their infant associated with daily depressed mood?
- RQ3: Do parents' perceptions of their responsiveness moderate the association between smartphone use and depressed mood on a day-to-day basis?

Based on our conceptual model and prior literature, we hypothesized that:

- H1: Greater smartphone use would be associated with greater depressed mood on a day-to-day basis.
- H2: Parent perceptions of lower responsiveness to their infant would be associated with greater depressed mood on a day-to-day basis.

Methods

Participants and procedures

We analyzed data from 264 individual parents (76% mothers; 79% Non-Hispanic Caucasian; $M_{age} = 30.82$ years, $SD = 4.82$; $Median\ income = \$70,000$, $M = \$79,942$, $SD = \$47,540$) of infants ($M_{age} = 6.65$ months, $SD = 3.51$, $Range = 1-13$ months) from an NIH-funded study (*Healthy Digital Habits in Parents of Infants*; R21NR019402), who consented, completed an online baseline survey, and then participated in 8 days of phone use measurement (via an app installed on their smartphone; *Chronicle* for Android users, *RescueTime* for iPhone users) and nightly surveys. The apps collected continuous phone use data, and using MATLAB and Python scripts we converted this use into amount of phone use in 15-min intervals across the entire 8 days. Each night, in addition to completing measures of depressed mood, responsiveness, and stressful child behavior, parents also completed a time diary (rating various activities in 15-min intervals across their day—such as time around child, child feedings, sleep, and so forth). Our MATLAB and Python scripts were also utilized to merge the phone use and time diary data together and to create the phone use around child variable (described in the Measures). Phone use measurement and daily survey completion rates were typically high. Specifically, in our modeling, 95% had 5 or more days of phone use around child data ($Mean\ days = 7.38$, $SD =$

1.35, *Total days* = 1,949). Participants were recruited through a Midwestern healthcare system and via announcements on social media and in public spaces. Greater details about recruitment, the sample, procedures, and phone use variable creation are found in [McDaniel et al. \(2023\)](#).

Measures

Phone use around infant

Using the merged phone use/time diary data, we calculated the amount of time each day the parent was on their phone during times around their infant (including physically near or playing with infant, but not including infant feeding time, when the infant slept, or when the parent marked that someone else had used their phone). We then created a proportion variable by dividing the phone around infant time by the total time around infant, and days when the parent had spent no time with their infant were coded as missing. This gave us the proportion of child time spent on their phone around their infant during general (not feeding) times for each day.

Phone use during infant feeding

We created this variable in the same way as the phone use around infant variable, except we focused only on the infant feeding times. This gave us the proportion of feeding time spent on their phone each day.

Depressed mood

We adapted the CES-D Short Form (CES-D-SF; [Levine, 2013](#)) to measure the frequency of six depressive symptoms each day (e.g., “I felt depressed,” “I felt everything I did was an effort”); we did not include the seventh item (“My sleep was restless”) from the CES-D-SF on our daily surveys, as we desired a measure of depressed mood during the day, not from the previous night. Others have also adapted and successfully utilized the CES-D in daily survey research to measure daily depressed mood ([Steers et al., 2014](#)). In our study, parents rated each item on how often they had felt that way today on a 5-point scale ranging from 0 (*None of the time*) to 4 (*All or almost all the time*). Multi-level factor analysis indicated that one factor at both the within- and between-levels fit the data well, $\chi^2(16) = 53.98$, $p < 0.001$, RMSEA = 0.03, CFI = 0.98, TLI = 0.96, SRMR within = 0.02, SRMR between = 0.02. Within- and between-person reliability also suggested that the depressed mood scale adequately assessed the construct at both levels (WP reliability = 0.75, BP reliability = 0.98). Items were averaged to produce an overall depressed mood score for each day.

Perceptions of delayed responsiveness

We measured delayed responsiveness each day with a single item from the Maternal Infant Responsiveness Instrument (MIRI; [Amankwaa et al., 2007](#)) and adapted to the daily context (“Today, I feel I sometimes responded slowly to my baby”). Parents rated their perceptions on a 5-point scale from 1 (*Strongly disagree*) to 5

(*Strongly agree*). Thus, higher scores represented greater perceived delayed responsiveness.

Daily control variables

As parenting stress and sleep issues can influence parent mood (e.g., [Meltzer and Mindell, 2007](#); [Fang et al., 2022](#)), we also measured stressful infant behavior and parent sleep hours. Parents rated their infant’s behavior each day on a single item (“Today, how much did you experience your infant’s behavior as stressful?”) on a 10-point scale, from 1 (*Not at all*) to 10 (*Very much so*). Each day, parents also reported how many hours they slept the previous night (similar to the Pittsburgh Sleep Quality Index, PSQI; [Buysse et al., 1989](#)). As the amount of time parents were with their infant each day varied from parent-to-parent and across days within parents, we also measured how many hours parents reported being with their infant each day (from their time diary ratings).

Data analysis

We first examined descriptives and bivariate correlations at the between-person level (see [Table 1](#)). Then, to examine our hypotheses and research question we ran two multilevel models (MLM) in SAS Proc Mixed predicting daily depressed mood (one model including phone use around child in general as a predictor and another model including phone use during feedings as a predictor). MLM was used as there was nesting in the data (i.e., participants completed multiple days). We first ran an the intercept-only model to examine the amount of variance accounted for by the intercept (ICC = 0.645), which indicated that about 35.5% of the variance in daily depressed mood is likely due to within-person differences. Then, we entered our predictors and controls (as seen in [Table 2](#)). All daily variables were split into their between-person (differences across parents) and within-person (differences from day-to-day within parents) portions before being entered into the models ([Bolger et al., 2013](#)). Although we were most interested in the daily, within-person processes, this also allowed us to compare the within-person processes with the between-person differences. Moderation of the potential impact of daily phone use on daily parent mood by parent perceptions of responsiveness was examined by entering the interaction term at both the between-person and within-person levels (i.e., see *BP phone X BP responsiveness* and *WP phone X WP responsiveness* in [Table 2](#)). Significant interactions were then explored by plotting the predicted values of depressed mood at different values of the variables (specifically, the average and one standard deviation above and below¹). The simple slopes at different levels of moderator variable were then calculated.

1 At the between-person level, the values represent the sample average and sample standard deviations across all days of data. At the within-person level, the values represent the participant’s average (and technically also the sample average due to the coding of each participant’s average level as 0 in the within-person variable) and the standard deviation across the sample in within-person fluctuations across all days.

Results

Descriptives and bivariate correlations

On average, parents rated themselves as experiencing a low degree of depression symptoms most days (Table 1), although as we examined response frequencies we found that parents rated at least one depressive symptom as occurring on 75% of all days collected. Parents spent on average one-quarter of their time around their child and during feedings on their smartphone (Table 1). Depending on the parent, this average ranged from 2 to 75%. Also, 50% of all days collected showed one-quarter or more of their child time on their phone. On average, parents did not report that their responses to their infant were slow, although parents expressed somewhat of a delay on 62% of days. Yet, these averages mask the daily variability. Indeed, intraclass correlation coefficients suggest that about 36% of the variance in depression was due to within-person variability (i.e., variance that cannot be accounted for by between-person differences), while the within-person daily variability was even greater for phone use around infant (56%), phone use during feeding (65%), and delayed responsiveness (65%).

Between-person bivariate correlations (see Table 1; i.e., correlations among the variables, when variables were averaged across all days within each parent) revealed that those parents with greater phone use around their infant, on average, also tended to show greater average depressed mood, although this was not true of those who showed greater average phone use during infant feeding times. Those with greater depressed mood on average also tended to perceive their responsiveness as slower and infant behavior as more stressful on average. As would be expected, they also reported fewer average sleep hours.

RQ1/H1: greater smartphone use and greater depressed mood

Our MLM results (Table 2) revealed that depressed mood and phone use around infant were associated at the within-person level.

In support of our hypothesis, this suggests that on days when parents used their phone more than usual around their infant (not during feeding) they also experienced more depressed mood ($b = 0.20, p = 0.03$). However, contrary to our hypothesis, this main effect was not observed for phone use during infant feeding times ($b = 0.11, p = 0.17$). Between-person results suggested similar results, namely that those who engaged in greater phone use around their infant compared to those who engage in less use showed greater depressed mood on average ($b = 0.94, p < 0.01$), although this was not the case for those who engaged in greater phone use during feeding ($b = 0.34, p = 0.21$).

RQ2/H2: perceptions of lower responsiveness and greater depressed mood

MLM results (Table 2) revealed within-person daily associations between perceptions of delayed responsiveness and depressed mood. In support of our hypothesis, on days when parents perceived themselves as being slower to respond to their infant, they also showed greater depressed mood (Model 1 and 2 $bs = 0.03, ps = 0.01$). Interestingly, no significant between-person association was found (Model 1 $b = 0.01, p = 0.86$; Model 2 $b = 0.04, p = 0.46$), suggesting that parents who generally perceived themselves to be less responsive to their infant did not have higher depression symptoms compared to parents who generally perceived themselves to be more responsive.

RQ3: moderation by perceptions of responsiveness of effect of smartphone use on depressed mood

Our MLM results (Table 2) revealed significant moderation by parents' perceptions of their responsiveness at the within-person level for phone use around infant ($b = 0.33, p < 0.01$) and

TABLE 1 Between-person descriptives and correlations among daily study variables.

	Depressed mood	Phone use around child	Phone use during feeding	Delayed responsiveness	Stressful child behavior	Parent sleep hours	Time with child (hours)
Depressed mood	–	0.16**	0.07	0.11‡	0.26***	–0.20**	0.03
Phone use around child		–	0.77***	0.04	–0.04	–0.13*	0.11
Phone use during feeding			–	–0.03	–0.06	–0.19**	0.16**
Delayed responsiveness				–	0.42***	–0.08	0.00
Stressful child behavior					–	–0.13*	0.07
Parent sleep hours						–	0.03
Time with child (hours)							–
Mean	0.68	0.27	0.27	2.07	2.58	6.77	6.91
SD	(0.64)	(0.12)	(0.14)	(0.74)	(1.17)	(1.08)	(2.27)

N = 264.

‡p = 0.06.

*p < 0.05.

**p < 0.01.

***p < 0.001.

TABLE 2 Unstandardized estimates for the multilevel models of daily phone use around their infant and perceived delayed responsiveness to infant and associations with depressed mood.

Fixed effects	Model 1: Phone use around child as predictor of daily depressed mood		Model 2: Phone use during feeding as predictor of daily depressed mood	
	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>
Intercept	0.76***	(0.045)	0.74***	(0.043)
Day	−0.02***	(0.005)	−0.02***	(0.005)
Gender	−0.09	(0.09)	−0.12	(0.09)
Between-person (BP) portion of daily variables				
BP sleep hours	−0.09**	(0.03)	−0.11***	(0.03)
BP child behavior	0.12***	(0.03)	0.12***	(0.03)
BP child hours	0.00	(0.02)	0.00	(0.02)
BP phone use around infant	0.94**	(0.30)	0.34	(0.27)
BP delayed responsiveness	0.01	(0.05)	0.04	(0.05)
BP phone X BP responsiveness	−1.29***	(0.37)	−0.87*	(0.35)
Within-person (WP) portion of daily variables				
WP sleep hours	−0.04***	(0.01)	−0.03***	(0.01)
WP child behavior	0.03***	(0.01)	0.03***	(0.01)
WP child hours	−0.01**	(0.00)	−0.01*	(0.01)
WP phone use around infant	0.20*	(0.09)	0.11	(0.08)
WP delayed responsiveness	0.03*	(0.01)	0.03*	(0.01)
WP phone X WP responsiveness	0.33**	(0.11)	0.25**	(0.09)

Gender is coded 0 = female and 1 = male. Day is centered on day 1. Daily variables were split into between-person and within-person portions and both portions were included in each model. Model 1 *N* = 264, Model 2 *N* = 260.

****p* < 0.001.

***p* < 0.01.

**p* < 0.05.

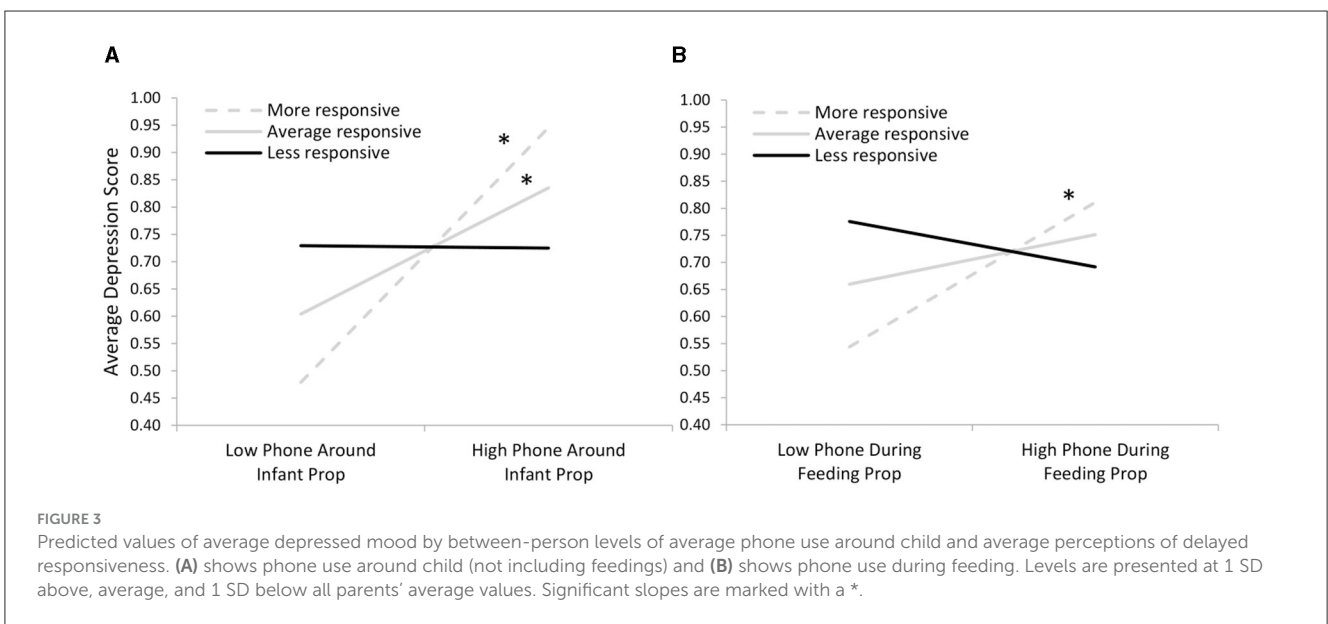
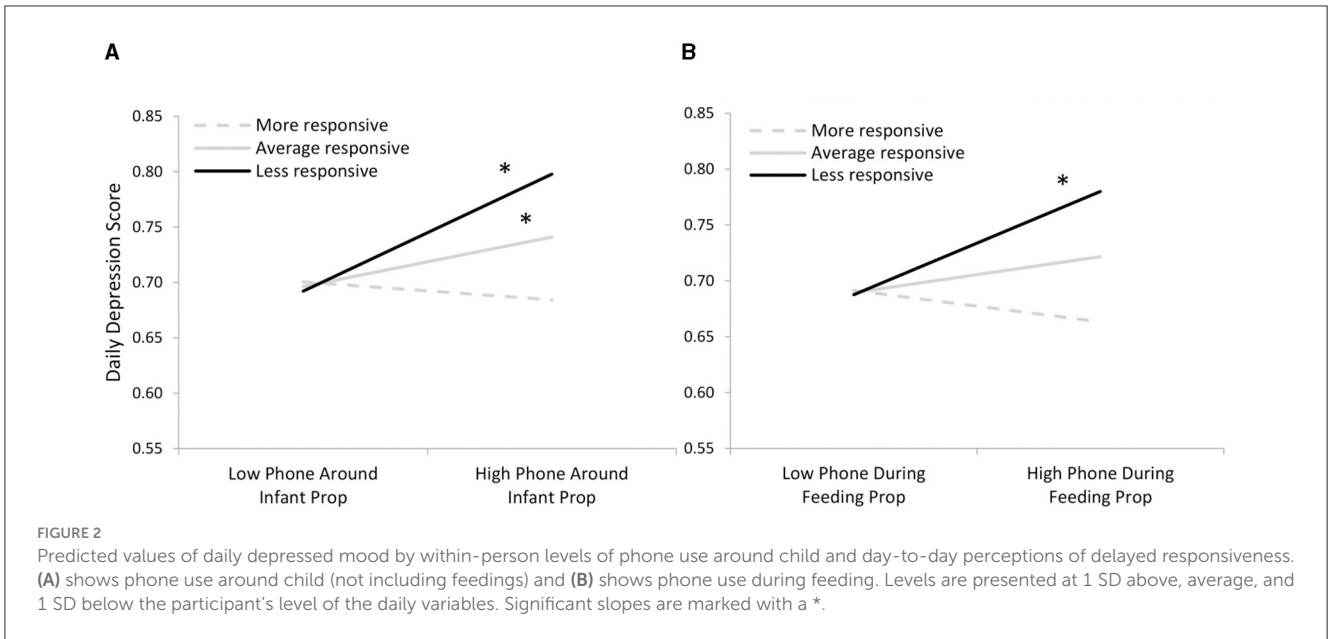
phone use during feeding ($b = 0.25$, $p < 0.01$). Between-person moderation effects or perceived responsiveness were also observed for phone use around infant ($b = -1.29$, $p < 0.001$) and phone use during feeding ($b = -0.87$, $p = 0.01$). Figures 2 and 3 display the plots of the predicted values of depression at different values of the variables (e.g., +1SD, −1SD), and Table 3 shows the simple slopes at these chosen values. In probing these interactions, at the within-person level, parents perceived themselves as greater than or equal to 0.82 points less responsive than their usual (+1SD) on 14% of days, and parents perceived themselves as greater than or equal to 0.82 points more responsive than their usual (−1SD) on 14% of days. At the between-person level, 19% of parents perceived themselves as greater than or equal to 0.74 points less responsive than the sample average (+1SD), and 18% of parents perceived themselves as greater than or equal to 0.74 points more responsive than the sample average (−1SD).

At the within-person level (see Figure 2), on days when parents perceived themselves as at their typical level of responsiveness or lower, phone use around infant showed a significant positive association with depression symptoms—but there was no significant association on days when parents perceived themselves as more responsive than their typical amount. Similarly, on days when parents perceived themselves as less responsive than usual, more phone use during feeding was significantly associated with higher depression symptoms.

Moderation results appeared different at the between-person level (see Figure 3). Average phone use around infant showed significant associations with average depression symptoms only among parents with average and higher general levels of perceived responsiveness. Similarly, average phone use during feeding showed significant associations with average depression symptoms only among parents with higher general levels of perceived responsiveness. In other words, among parents who perceived themselves as having lower general levels of responsiveness, there were no associations between average levels of phone use and average levels of depression symptoms.

Discussion

In this study of parents of infants, we used intensive longitudinal data collection to examine day-to-day fluctuations in parental smartphone use, depression symptoms, and their perceptions of their responsiveness to their infant. We found significant within-person daily associations. Specifically, on days when parents used their phone more around their infant, they also showed greater depression symptoms. Additionally, on days when parents perceived themselves as being less responsive to their infant, they also showed greater depression symptoms. We



also found significant moderation of the daily association between phone use and depression by perceptions of responsiveness.

These findings support our hypothesis (H1) that parents would feel more depressed on days when they engaged in greater smartphone use around their infant, which is a novel contribution to the literature, as prior work has typically examined these processes utilizing cross-sectional, between-person data (e.g., McDaniel, 2019 for a review). Regardless of overall typical levels of phone use, depression, and other between-person factors, we show that a parent's own mood state is connected on a daily basis with their smartphone use. This process is likely bidirectional, as we know that parents often turn to phone use as a coping or self-regulation strategy (Radesky et al., 2016; Torres et al., 2021; Wolfers et al., 2023a,b). At the same time, heavier phone use during child time on a given day might impact mood and/or lead

to feelings of distraction, wasted time, or other self-perceptions (via negative social comparisons, disappointment in not meeting one's expectations for phone use during parenting, etc.; Sagioglou and Greitemeyer, 2014; Radesky et al., 2016; Coyne et al., 2017; Kirkpatrick and Lee, 2022; Mikić and Klein, 2022). Moreover, we controlled for daily sleep quality and stressful infant behavior in our multi-level models, so the links between mood and smartphone use we demonstrated exist independent of sleep-displacement or parenting stress. Future work should examine these stress-to-phone use processes with intensive data.

We also found support for our hypothesis (H2); on days when parents felt more depression symptoms, they also perceived themselves as being less responsive to their infants. These daily fluctuations in mood and infant responsiveness could be bidirectional, in that depressed mood might lead to flatter

TABLE 3 Unstandardized effects of phone use on daily depressed mood at different levels of perceived delayed responsiveness.

Fixed effects	Model 1: Phone use around child as predictor of daily depressed mood		Model 2: Phone use during feeding as predictor of daily depressed mood	
	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>
Between-person (BP) phone use effect				
At +1 SD BP delayed responsiveness	−0.09	(0.38)	−0.49	(0.47)
At average BP delayed responsiveness	0.94**	(0.30)	0.34	(0.27)
At −1 SD BP delayed responsiveness	1.82**	(0.70)	0.93*	(0.46)
Within-person (WP) phone use effect				
At +1 SD WP delayed responsiveness	0.41**	(0.15)	0.28*	(0.12)
At average WP delayed responsiveness	0.20*	(0.09)	0.11	(0.08)
At −1 SD WP delayed responsiveness	−0.004	(0.12)	−0.02	(0.10)

***p* < 0.01.**p* < 0.05.

affect or psychomotor slowing that influences responsiveness to infants. Alternatively, because parents may experience reciprocal interactions with infants as mutually satisfying, a more responsive day might help lift a parent's mood. Thus, at a within-person level we were able to detect effects for fluctuations in daily mood. Yet, our between-person results were not consistent with prior research comparing parents with and without clinical depression (e.g., Campbell et al., 1995; Paris et al., 2009). Our sample of parents tended to have lower daily depression symptoms on average—suggesting that researchers may need to study parents with more clinically significant postpartum depression or major depressive disorder diagnoses to detect and better understand between-person differences.

Most interestingly, we found interactions between parent perceptions of responsiveness, smartphone use, and depression symptoms that may yield insights into mechanisms underlying these associations. On a within-person level, it was only on days when parents felt they had been about average or less responsive to their infants that smartphone use around the infant and depression symptoms were linked. This could potentially be explained by greater parental guilt experienced on these days. Previous cross-sectional and interview studies have found that parents express using their phones when feeling down or stressed but also feel guilty regarding smartphone use around their child (Radesky et al., 2016; McDaniel et al., 2022a; Wolfers et al., 2023a). It is also possible that positive, responsive interactions with their infant buffer parental mood, in that they feel more effective or emotionally regulated, so that smartphone use has less of a negative effect on mood. We did not examine the types of apps that parents used around their child, but this is an important area for future research. For example, using the camera and messaging features might allow a parent to take photos or videos while playing with their child and share their positive experience with others. Whereas using apps with possibly more negative emotional content (e.g., news, social media) may not support parents feeling effective in their parenting and time.

Finally, it is also interesting that associations with mood, although still present, were weaker for phone use during infant feeding time as compared to phone use during other general infant times. Some prior work has suggested that the potential impacts of

phone use during infant feeding times may not be as negative and sometimes could lead to positive outcomes for parents (e.g., Coyne et al., 2022). It may also be that parents interpret and evaluate their phone use during feeding differently, perhaps viewing it less negatively than phone use during other times around their infant. This should be tested by future work.

Surprisingly, when examining between-parent differences, moderated effects were reversed as compared to the within-person effects. In parents whose average self-reported responsiveness was high, higher average smartphone use during child time and feeding was linked to higher average depression symptoms. Yet, in parents who generally reported lower perceived responsiveness, phone use was not linked to average mood. This contrary moderation effect might be explained by different self-expectations between parents who generally rate themselves as highly responsive as compared to those who generally rate themselves as being less responsive. For example, highly responsive parents might experience more guilt with higher phone use, as they might expect themselves to be highly attuned to child behavior and are frustrated when parent-child interactions are interrupted by smartphone use. Indeed, recent research has found that smartphone interruptions may be perceived as intrusive or disruptive to parents during times with their infants, contributing to daily stress (Munzer et al., 2024). Infancy is also a time when parents establish their identity and self-efficacy as a new parent, so higher smartphone use may be stressful if it conflicts with their own expectations for their parenting behavior (Kildare and Middlemiss, 2017; McDaniel, 2019). It is also possible that parents who report lower perceived responsiveness use their smartphones differently (e.g., different content) than parents who see themselves as more responsive; either way, our findings suggest that differences between parents in their typical levels of smartphone use and mood symptoms are not homogenous among all parents.

Our results have clinical implications, particularly for professionals who support parents of infants through public health nursing, home visiting programs, or early parenting or relational health interventions. Clinicians can help new parents reflect on fluctuations of their daily mood that correspond to either interactions with their infant or their technology use. This process might include looking at the parents' phone usage

readout together (i.e., Screen Time or Digital Wellbeing tools) and facilitating a discussion of which app usage contributes most to feelings of stress, negative social comparison, distraction from infant interactions, or poor sleep. Because patterns of phone usage vary considerably between parents (McDaniel et al., 2024b), a one-size-fits-all approach will be less effective. Instead, clinicians can use shared-decision making and motivational interviewing to help the parent come up with feasible behavioral changes regarding technology use that align with their parenting values. In addition, the American Academy of Pediatrics (Hill et al., 2016), recommends that parents complete a Family Media Plan that includes boundaries (e.g., no-tech times or places) around not only their children's technology use, but their own. Pediatric clinicians could also assuage the guilt parents may feel about their technology use, which can be a counterproductive mindset (Moreno and Radesky, 2023; McDaniel et al., 2024a); and instead focus on pragmatic strategies for helping their daily interactions with their infants feel more positive and responsive (e.g., McDaniel, 2020).

Limitations of this study include its predominantly white non-Hispanic sample, although our cohort reflects the racial/ethnic diversity of the midwestern state in which data were collected. We also relied upon a single item to measure daily parent perceived responsiveness. Single item measures are common within intensive daily data designs due to participant burden. However, results should be replicated in future work utilizing a more extensive measure of perceptions of responsiveness; for example, slowness of response may not fully or always be the best indication of responsiveness. Our focus was not to assess actual responsive behavior, but future work could likely benefit from assessing both behavior and perceptions—and intensive longitudinal observational measures (e.g., wearable audiorecorders such as LENA) may be of worth for measuring parent responsiveness. Finally, depression was the sole parent mental health variable we tested in this analysis. It is possible that other mental health disorders common in the perinatal period (e.g., anxiety) could be comorbid with depression and/or driving the associations with smartphone use (Hashemi et al., 2022; Santander-Hernández et al., 2022). Additionally, depression and other mental health disorders may have different associations with general smartphone use than they do with clinical overuse (i.e., smartphone addiction), and this possibility should be explored in future studies.

Despite these limitations, one strength of the current study is our intensive daily data design which allowed for the examination of within-person associations. In other words, we were able to get closer to life as it is really lived (Bolger et al., 2003) and to better match our conceptualizations of mechanisms of change and fluctuation in parent phone use and mood with real-life data (Collins, 2006). Additionally, we had objective measures of parent smartphone use (passively sensed via an app installed on parents' smartphones); thus, we have more trust in our estimates of phone use and phone use effects—instead of relying on parent reports of phone use which are often inaccurate (e.g., Yuan et al., 2019). Although the current data allowed for an examination of daily associations, it is not known whether smartphone use predicts mood or mood predicts smartphone use on a momentary basis—indeed, prior work has shown that both pathways are viable and it is often a bidirectional process (e.g., Jun, 2016; Cui et al., 2021; Zhang et al., 2023). Future work likely would need to examine

mood states at an even more detailed, momentary level to fully assess the directionality of these pathways.

Overall, the current study expands upon the previous literature by examining within-person, daily processes amongst parent smartphone use, depressed mood, and perceptions of responsiveness to infants. Objectively-measured parent smartphone use during time around their infant is significantly linked with depressed mood on a daily basis. Interestingly, this is not true on days when parents perceive themselves to be more responsive to their infant, suggesting that parent judgements and perceptions of their parenting behavior may impact the potential effects of parent phone use on parent mood. This is the first study utilizing intensive daily data to examine how parent perceptions may alter the effects and potential meaning of parent phone use for parenting, and it appears promising that future work should expand on considering the links and interactions between actual phone use and perceptions when discussing the potential impacts of smartphone use.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Parkview Health Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The Ethics Committee/institutional review board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because the research presented no more than minimal risk of harm to subjects and involved no procedures for which written consent is normally required outside of the research context. Participants consented to the study via an online consent form where they typed their study ID number and selected that they consent to participate.

Author contributions

BM: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. SU: Writing – original draft, Writing – review & editing. JP: Conceptualization, Funding acquisition, Writing – review & editing. VC: Software, Validation, Writing – review & editing. MD: Conceptualization, Funding acquisition, Writing – review & editing. JR: Conceptualization, Funding acquisition, Investigation, Resources, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships

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