



CORRESPONDENCE

Mothers' smartphone use and mother-infant interactive behavior in the postpartum period

Pediatric Research (2022) 91:8–11; <https://doi.org/10.1038/s41390-021-01451-4>

INTRODUCTION

As mobile digital devices such as smartphones have become integral parts of modern family life, more knowledge is needed about parents' device use and the consequences for parenting and children's development.¹ The current preliminary study examines the association between mothers' habitual smartphone use and mother–infant interactive behavior in the postpartum period.

Concerns are raised that mobile device use may cause interruptions in interpersonal interactions, a process termed *technoference*.² It has been suggested that smartphone use is associated with divided attention, demands on working memory, distractedness, and decreased ability to distinguish between relevant and irrelevant information.³ In parent–child interactions, continuous partial inattention and distraction due to mobile devices might decrease responsiveness to external stimuli, including infant or child cues,^{4,5} and may interfere with parental sensitive responsiveness, that is, the ability to pick up children's cues, interpret them correctly, and respond to them in a timely manner and appropriately.⁶ Although sensitivity has consistently been shown to be a key factor for children's social-emotional development,⁷ questions remain about associations with parental smartphone use.

A review⁸ including 27 studies concludes that parents' mobile device distractions while caring for their children have negative implications for parent–child interactions. Specifically, studies indicate that parental smartphone use is associated with decreased responsiveness to children and fewer verbal and nonverbal interactions.^{9,10} Infants showed reduced social engagement and increased negative emotionality and avoiding behaviors when mothers were looking at a smartphone screen.¹¹ Recently, it has been shown that more parental mobile device use was indeed associated with more *technoference* in parent–child interactions at 3 years, which in turn was associated with child behavior problems.¹² More information is needed about how much parents use their phones in the presence of their children⁸ using passive sensing to measure smartphone use, considering recent findings that self-report measures of smartphone use are unreliable.¹³

The aims of the current study were to examine (1) the extent of mothers' habitual smartphone use as measured by passive sensing, and (2) associations between mothers' habitual smartphone use and mother–infant interactive behaviors. We hypothesize that higher maternal habitual smartphone use is associated with less optimal mother–infant interactive behavior.

METHODS

Participants were 23 mothers from Copenhagen, Denmark, and their 3–7-month-old firstborn infants. Mothers were recruited for this preliminary cross-sectional study via social media, and activity

clubs for babies and parents. The study was conducted from August 2016 to January 2017. Mothers had to own a smartphone of the brand iPhone, as the app used to register mothers' smartphone use was only available for this type of phone at the time of data collection. All mothers signed a written consent. As shown in Table 1, this was a highly educated, low-risk sample. The majority of mothers had a bachelor or master's degree, and most were in a stable relationship. Depressive symptoms were low. All mothers were on maternity leave and children did not attend any formal daycare.

Mother–infant interactive behavior was assessed during a home visit using a 10-min free-play situation without the smartphone present. Mothers were instructed to interact with their infant as they normally would. Video-recordings of the interaction were rated using the Coding Interactive Behavior manual (CIB) (R. Feldman. Coding interactive behavior manual, 1998, unpublished manual). CIB includes 18 parental, 8 infant, and 6 dyadic behavioral codes (e.g., “overriding behavior,” “positive affect,” “dyadic fluency”) rated on a scale from 1 (minimal) to 5 (maximum). We used four behavioral composites and three single codes of interactive behavior (Table 1), that is, maternal *sensitivity*, *forcing*, and *overriding*, infant *involvement* and *negative emotionality*, and dyadic *reciprocity* and *negative states*. Interactions were coded by a blinded, trained, and reliable coder (first author). Interrater reliability with a second coder was high (86.7–100% agreement on 20% of the sample). A more detailed description of the interactive behaviors coded with the CIB can be found in Supplementary Table 1.

Mothers installed the app *Moment*¹⁴ on their phones. Smartphone use was assessed by passive sensing during the week following the home visit. The app registers “screen time” as the frequency of pickups (i.e., unlocking the phone), and duration of use for each pickup (i.e., time that the screen is on). This means that passive use of the phone when the screen is off, for example, for listening music, is not counted (see, e.g., <https://moment.io/faq>). Participants were instructed to use their smartphone as they normally would and were informed that all data would be anonymized. We used the data of smartphone use collected for 3 days from Wednesday morning until Saturday morning to allow for normalization period to minimize influential bias.

Mothers completed a paper and pencil baby diary consisting of 30-min intervals where they indicated when they were alone with their infant and the infant was awake. In total, the home visit took ~60 min, and completing the diary took ~15 min/day. Using the diary data in conjunction with the smartphone use data, we calculated three indices of maternal smartphone use while the mother was alone with the awake infant: (1) total minutes per day using the smartphone, (2) percentage of time alone with the infant that mothers used the smartphone, and (3) number of pickups.

We first examined mothers' daily smartphone use descriptively. Second, we used multivariate linear regression analyses to examine whether our three indices of maternal smartphone use were associated with interactive behavior using the CIB composites as dependent variables. We further explored significant associations ($p < 0.05$) using post hoc analyses with the separate

Received: 8 July 2020 Revised: 23 December 2020 Accepted: 16 February 2021
Published online: 17 March 2021

Table 1. Sample characteristics, mothers' smartphone use, and interactive behavior.

	<i>n</i>	%	Min.	Max.	<i>M</i>	<i>SD</i>
Age of the infant (months)	28		3	7	4.6	1
Infant sex	28					
Girls	9	32.1				
Age of mother (years)	28		25	38	30.6	3.6
Highest level of finished education	28					
High school	2	7.1				
Medium higher education	4	14.3				
Bachelor	5	17.9				
Long higher education	17	60.7				
Marital status	28					
In a relationship with other parent	27	96.4				
Minutes per day alone with awake infant	26	92.9	0	520	228.8	119.2
Mothers' depressive symptoms, EPDS	28	100	1	10	4.8	2.7
Mothers' smartphone use ^a						
Duration (min/day)	23		68	227	146	49
Number of pickups/day	23		11	77	39	16
Duration while alone with the awake infant (min/day)	23		2	90	34	22
Number of pickups/day while alone with the awake infant	23		2	22	9	5
% Time using the phone while alone with the awake infant	23		1	31	14	7
Interactive behavior	27	96.4				
Maternal sensitivity ^b			2.4	4.5	3.7	0.5
Maternal forcing ^c			1	4	2.9	1
Maternal overriding ^c			1	4.5	2.3	1
Child involvement ^d			1.4	3.9	2.8	0.5
Child negative emotions ^c			1	4	1.6	0.8
Dyadic reciprocity ^e			2	4.7	3.8	0.8
Dyadic negative states ^f			1	3.5	1.6	0.8

^aNumbers are means calculated over days 1–3 of data collection.

^bMaternal sensitivity composite (Cronbach's $\alpha = 0.86$) consisting of codes for Acknowledging, Imitating, Elaborating, Gaze, Positive affect, Vocal appropriateness, Appropriate range of affect, Resourcefulness, and Supportive presence.

^cSingle code.

^dChild involvement composite (Cronbach's $\alpha = 0.74$) consisting of codes for Gaze, Positive affect, Alert, Initiation, and Vocalization.

^eDyadic reciprocity composite (Cronbach's $\alpha = 0.90$) consisting of codes for Reciprocity, Adaption regulation, and Fluency.

^fDyadic negative states composite (Cronbach's $\alpha = 0.86$) consisting of codes for Constriction and Tension.

items of the relevant CIB composite as dependent variables. To maximize statistical power, we report unadjusted analyses, as controlling for covariates (i.e., maternal depressive symptoms as assessed with the Edinburgh Postnatal Depression Scale,¹⁵ educational level, mother's age, infant's age and sex) did not change the effect estimates by >15%.

RESULTS

Passive sensing of mothers' smartphone use revealed that the mothers spent an average of 2 h and 26 min ($M = 146$, $SD = 49$)

per day on their smartphone and picked up their phone an average of 39 times a day ($SD = 16$). Mothers used their smartphone 14% of the time they spent alone with the awake infant (range: 1–31%, $M = 34$ min, $SD = 22$ min) spread over nine pickups ($SD = 5$) (Table 1).

Multivariate linear regression analyses (Table 2) indicated that longer duration of smartphone use was significantly associated with lower maternal sensitivity ($B = -0.01$, $SE = 0.01$, $p < 0.05$). Additional linear regression analyses revealed that this association was largely driven by negative associations of duration of smartphone use with maternal acknowledgement ($\beta = -0.45$, $p < 0.05$) and appropriate range of affect ($\beta = -0.52$, $p < 0.05$). Duration of smartphone use was not significantly associated with other maternal, infant, or dyadic interactive behaviors. Likewise, the number of smartphone pickups was not associated with maternal, infant, or dyadic interactive behavioral composites or codes.

DISCUSSION

The present study examined habitual smartphone use in mothers of 3–7-month-old infants and associations with mother–infant interactive behavior. Longer duration of maternal smartphone use while being the infant's only interactive partner was cross-sectionally associated with lower sensitivity in mothers.

Our study provides new information about mothers' smartphone use while being with their awake infant. We found a wide range in duration of mothers' smartphone use and number of pickups, suggesting that mothers in our study are a heterogeneous population of smartphone users despite the homogeneous sample composition in terms of high education and low psychosocial risk. While some mothers did not use their phone at all while being alone with the awake infant, others spent up to a third of this time on the phone. These findings correspond with previous studies of how parents are using their phone in different settings while taking care of older children.^{2,9,16,17} On average, mothers in the current study used their smartphone considerably less than parents of children aged 12 months to 5 years in a recent study¹⁰ that also used passive sensing to measure smartphone use (234 min).

We found that longer duration of smartphone use when mothers were alone with the awake infant was associated with lower maternal sensitivity. Post hoc analyses indicated that this association was mainly explained by associations with *acknowledgement* and *appropriate range of affect* of the mother. These findings are in accordance with theories about *technoference*,^{2,4} which suggest that use of digital devices may interrupt interpersonal interactions. Our findings indicate that this may also be the case for some aspects of infant–mother interactions. However, due to the cross-sectional design, we cannot draw any conclusions with regard to the directionality of our findings: Alternatively, less sensitive mothers might have a tendency to use the smartphone more while with their infant, compared to more sensitive mothers, or associations may be bi-directional, for example, less sensitive mothers may tend to use the smartphone more, which in turn may decrease the level of sensitivity. We found no association between the number of times per day mothers picked up the phone and interactive behavior. Pickups might constitute brief instances of occasional inattention. It has been suggested that occasional inattention occurring in a generally responsive environment may not be problematic, but, in fact, necessary for the development of independence and problem-solving.¹⁸

Whereas previous studies in older children identified associations between higher parental use of smartphones in the presence of their children and problematic child behavior,¹² we found no associations between smartphone use and infant interactive behavior in the current study with 3–7 months olds. However, longitudinal studies are needed to examine associations with

Table 2. Association between maternal smartphone use when alone with the awake infant and mother-infant interactive behavior.

	Maternal			Child						Dyadic					
	Sensitivity			Overriding ^a		Forcing ^a		Involvement		Negative emotions ^a		Reciprocity		Negative states	
	N	B (SE)	p value	B (SE)	p value	B (SE)	p value	B (SE)	p value	B (SE)	p value	B (SE)	p value	B (SE)	p value
Duration of smartphone use (min)	23	-0.01 (0.01)	0.04	0.02 (0.01)	0.05	0.01 (0.01)	0.25	-0.01 (0.01)	0.38	0.01 (0.01)	0.49	-0.01 (0.01)	0.08	0.01 (0.01)	0.16
% of smartphone use	23	-0.03 (0.02)	0.06	0.01 (0.03)	0.71	0.50 (0.03)	0.12	-0.02 (0.02)	0.36	0.03 (0.03)	0.30	-0.03 (0.02)	0.25	0.02 (0.03)	0.37
Number of pickups	23	-0.01 (0.03)	0.69	0.03 (0.04)	0.46	0.00 (0.05)	0.99	-0.03 (0.03)	0.24	-0.01 (0.04)	0.72	-0.02 (0.04)	0.51	0.03 (0.04)	0.42

Note: B represents unstandardized regression coefficients.

^aRefers to a single coding item and not a composite. Results of multivariate regression analyses. Smartphone use is measured when the mother was alone with the infant and the infant was awake. % of smartphone use = percentage of time on smartphone of the total time spent alone with the infant and the infant was awake.

more long-term social-emotional development, considering that maternal sensitivity has consistently been shown to play a key role.⁷

Findings should be interpreted in the light of several limitations. First, as this is a preliminary study, the sample is small and statistical power is low, indicating a high risk of type II errors that might explain some of the nonsignificant findings. In addition, the homogeneous nature of this sample consisting of mothers with high educational level and low psychosocial risk limits generalizability. Therefore, our findings should primarily be used to generate hypotheses with regard to parental smartphone use and parent-child interactions that need to be tested in larger, more representative samples. Longitudinal and/or experimental studies are needed to shed light on the question of the directionality of the effects. Future studies should also include fathers, consistent with family systems approaches.¹² Also, future studies may examine in more detail whether different screen activities may have differential effects on parent-child interactions.

In conclusion, the present study suggests habitually higher maternal smartphone use in the presence of the infant is associated with and lower maternal sensitivity in mother-infant interactions, even when the smartphone is not present. Our study indicates the feasibility of using passive sensing of smartphone use in mothers of young children and suggest that mothers are a heterogeneous group of smartphone users. These preliminary findings warrant future studies about the role of maternal smartphone use for mother-infant interactions and later developmental outcomes.

AUTHOR CONTRIBUTIONS

A.T.: conception and design of the study, coding of interactive behavior, analysis and interpretation of data, drafting of the article, and final approval of the version to be published. A.H.M.: conception and design of the study, acquisition of data, analysis and interpretation of data, drafting of the article, and final approval of the version to be published. E.M.H.: conception and design of the study, acquisition of data, analysis and interpretation of data, drafting of the article, and final approval of the version to be published. M.S.V.: conception and design of the study, interpretation of the results, revising the article critically for important intellectual content, and final approval of the version to be published.

ADDITIONAL INFORMATION

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1038/s41390-021-01451-4>.

Competing interests: The authors declare no competing interests.

Statement of consent: All adult participants provided written informed consent.

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