

Digital Family Life: A Systematic Review of the Impact of Parental Smartphone Use on Parent-Child Interactions

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Abstract

Smartphone use among parents is rising sharply, as they seek connectedness with partners, friends and work during the sometimes socially disconnected times of parenthood. Since parents increasingly use smartphones while interacting with their children, there is a growing body of research about the implications of parental smartphone use for parent-child interactions. However, previous reviews have not examined whether the effects of parental smartphone use on parent-child interactions vary depending on children's age. Additionally, no systematic review has summarized the potential benefits of parents' smartphone use for parent-child interactions. Therefore, the goals of this systematic review were: (1) to explore the links between parental smartphone use and the quality of parent-child interactions in four different age groups of children; and (2) to review potential benefits of parental smartphone use for these interactions. Following PRISMA guidelines, a total of $k = 21$ papers met all eligibility criteria and were included in this review. Results suggest associations between parental smartphone use and parent-child interactions across all age groups, but the foci and outcomes of the studies differed. Only a few studies have focused on the potential benefits of parental smartphone use for parent-child interactions. The review provides an overview of areas of future research to explore how smartphone use changes family interactions. Families have to find adequate ways of dealing with new technology in everyday life, which inevitably affects the nature of their daily interactions.

Keywords: parental mobile phone use, parent-child relationship, parenting, technofence, digital media

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Digital media are ubiquitous in modern societies. In 2015 82% of adults (25–54 years) accessed the internet via a smartphone in Europe (Eurostat, 2016). In addition, 94% of adults use their smartphone on a daily basis for more than three hours a day in Austria (Mobile Marketing Association Austria, 2018). Interestingly, 34% of adolescents (aged 11–17 years) stated that they think their parents use their phone too often (Saferinternet, 2019). The permanent virtual connectedness of parents has resulted in a shift from traditional face-to-face interactions towards technology-based interactions (Stern & Messer, 2009), which inevitably affects everyday family interactions too. Similarly, the more adolescents used their smartphone, the lower they rated the overall quality of the relationship with their parents (Kildare & Middlemiss, 2017). Hence, there might be mutual effects of family members' smartphone use: Parents as well as their children seem to be absorbed by their smartphones in everyday family life, which likely affects parent-child relations.

The phenomenon of interference and interruption of everyday face-to-face interactions through technology, in particular

smartphones, has been referred to in the literature as “technofence” (McDaniel & Coyne, 2016). Recently, parental smartphone use and the implications for parent-child interactions have received increasing scientific attention (Kildare & Middlemiss, 2017). Parents are engaged in screen media on personal and work-related matters throughout the day, and thus likely also use smart devices during parent-child interactions (e.g. text messaging while playing with their children; Beamish, Fisher, & Rowe, 2019). The presence of digital media devices during family quality time (e.g. meals, playtime, and bedtime) may impair the social-emotional development of children, because parental attention is shifted away from their children's needs and towards their device (McDaniel & Radesky, 2018). Given the rise and topicality of this research area, two recent narrative reviews (Kildare & Middlemiss, 2017; McDaniel, 2019) outlined the impact of parental technofence on parent-child interactions. However, the reviews lacked a systematic approach, included a broad range of studies (including studies focusing on mobile devices other than smartphones), and exclusively focused on the negative effects on parenting (e.g. more accidents as parents are

distracted) as well as the negative effects on children (e.g. insecure attachment, irritated children).

The potential negative impact of technofence on parent-child relations can theoretically be explained by attachment theory (Ainsworth, 1979, Bowlby, 1969). According to attachment theory, parental sensitivity is one of the strongest predictors of high parent-child relationship quality and the children's secure attachment, which in turn, affect children's long-term social, psychological and health outcomes (e.g. Fearon, Bakermans-Kranenburg, van IJzendoorn, Lapsley, & Roisman, 2010). Parental sensitivity is conceptually defined as the parents' awareness of their child's needs, their accurate interpretation of those needs, and the contingent and appropriate response to those needs (Ainsworth, Blehar, Waters, & Wall, 1978). It is well conceivable that technofence impairs parental sensitivity. That is, when parents are distracted by their smartphones, they are likely to be less attentive and responsive to their children's needs, which can negatively affect child attachment and development (Kildare & Middlemiss, 2017).

The role of parental sensitivity for children's attachment has traditionally been examined in infancy. Especially in the first years of their lives, infants depend on their parents to survive, and with increasing mobility rely on their parents to guide them through challenges and to provide a secure base. However, albeit initially developed in infancy, attachment still has regulatory functions during middle childhood and through adolescence (Grossmann, Grossmann, Kindler, & Zimmermann, 2008). As children grow older, they need less parental support because they are more able to handle their emotions and feelings of distress independently, have a greater capacity for self-regulation, and receive increasing social support outside the family (Zimmer-Gembeck et al., 2017). Although adolescents less frequently express their attachment needs by physical proximity in times of stress, they still seek emotional support from their parents when needed (Zimmermann, Mohr, & Spangler, 2009). Hence, parental sensitivity is not only relevant in early childhood, but remains an important protective factor across the child's development through adolescence until young adults leave home.

Only a small number of studies have examined whether the effects of parental smartphone use on parent-child interactions vary depending on the age of the child. Moreover, no reviews have systematically investigated previous research about the impact of parental smartphone use across different developmental stages of children. This is particularly lamentable, as there is evidence that parents' use of information and communication technology increases with the age of children (Rudi, Dworkin, Walker, & Doty, 2015). Therefore, the first goal of this systematic review is to explore the role of children's age in the link between parental smartphone use and parent-child interactions, as this allows for a more thorough understanding of the meaning of technofence for families.

In addition, the existing literature has mainly focused on the negative effects of parental smartphone use on parent-child in-

teractions (McDaniel, 2019), for instance distraction of mothers while feeding their babies (Golen & Ventura, 2015) or while at the playground with their children (Hiniker, Sobel, Suh, Sung, Lee, & Kientz, 2015). Given the importance of awareness of this potential negative impact, it becomes evident that more research, especially longitudinal, is required to fully explore this highly relevant topic. Nevertheless, far less research has been devoted to date to investigating the possible benefits of parental smartphone use for family interactions. Recent research has begun to focus on benefits of smartphone use for children's and parents' feelings of connectedness in the family (Coynne, Padilla-Walker, Fraser, Fellows, & Day, 2014; Devitt & Roker, 2009), but, to our knowledge, no systematic review has summarized the potential benefits of parental smartphone use for parent-child interactions. Therefore, the second goal of this review is to address this gap.

The Current Review

This systematic review summarizes studies examining a specific form of technofence, i.e. the effects of parental smartphone use on parent-child interactions, with a focus on two main research questions:

First, do the links between parental smartphone use and the quality of parent-child interactions vary across four different age groups of children (infancy, preschoolers, school-age children, and adolescents)? We hypothesize that the impact differs insofar as with younger children parental sensitivity is impaired, whilst with older children the quality of parent-child interactions and perceived parental support are affected.

Second, what are the benefits of parents' smartphone use for parent-child interactions? We expect that there are possible benefits of parental smartphone use for parent-child interactions, which have been neglected in previous research that has focused on the negative consequences of technofence for parent-child interactions.

1 Method

1.1 Search Strategy

The systematic literature search followed PRISMA guidelines (Moher, Liberati, Tetzlaff, Altman, & the PRISMA Group 2009) and was conducted by the first author in June and July 2019. The following databases and search engines were searched for relevant literature by using a combination of key search terms in English and German (see Table 1 in the electronic supplements): Pubmed, Psychnet, Web of Science, Proquest, Ebsco, and Google Scholar. During the process of literature search, references included in previous reviews and studies were screened in terms of our eligibility criteria (see below). In addition, the existing literature/library of the research team was included as addition-

al records ($k = 27$). The title and abstract of 4,667 total records were screened by the first author. Among them, 4,565 records were excluded because abstract analysis revealed that they were unsuitable for the current review. As a next step, duplicates ($k = 43$) were removed. The remaining ($k = 59$) were given full consideration by a thorough full text analysis. In uncertain cases, the first author consulted the second author and discussed if the article should be included. Ultimately, a total of 21 records met all eligibility criteria and were included in this review (asterisk [*] in the reference list). The flow chart describes all stages of the selection process (see Figure 1).

1.2 Inclusion Criteria

To be included in the review, the studies had to meet the following criteria: (1) examining parental smartphone use during a parent-child interaction, defined as any form of spending time

together (eating, playtime, being in the same room); (2) using methods to assess the quality of the parent-child interactions (e.g. interaction quality, parental sensitivity etc.); and (3) the age of the children had to be between 0 and 18 years. To address our first research question (i.e. whether the effects of parental smartphone use vary across children's age), we predefined four age groups to categorize the different stages of child development:

- Age group 1: infants and babies (0–3 years);
- Age group 2: toddlers and preschool children (4–6 years);
- Age group 3: school-age children (7–10 years);
- Age group 4: adolescents (11–18 years).

1.3 Exclusion Criteria

Excluded were: (1) theoretical papers or book chapters and narrative reviews (not original research); (2) intervention studies aimed at improving parental media use, as these do not reflect

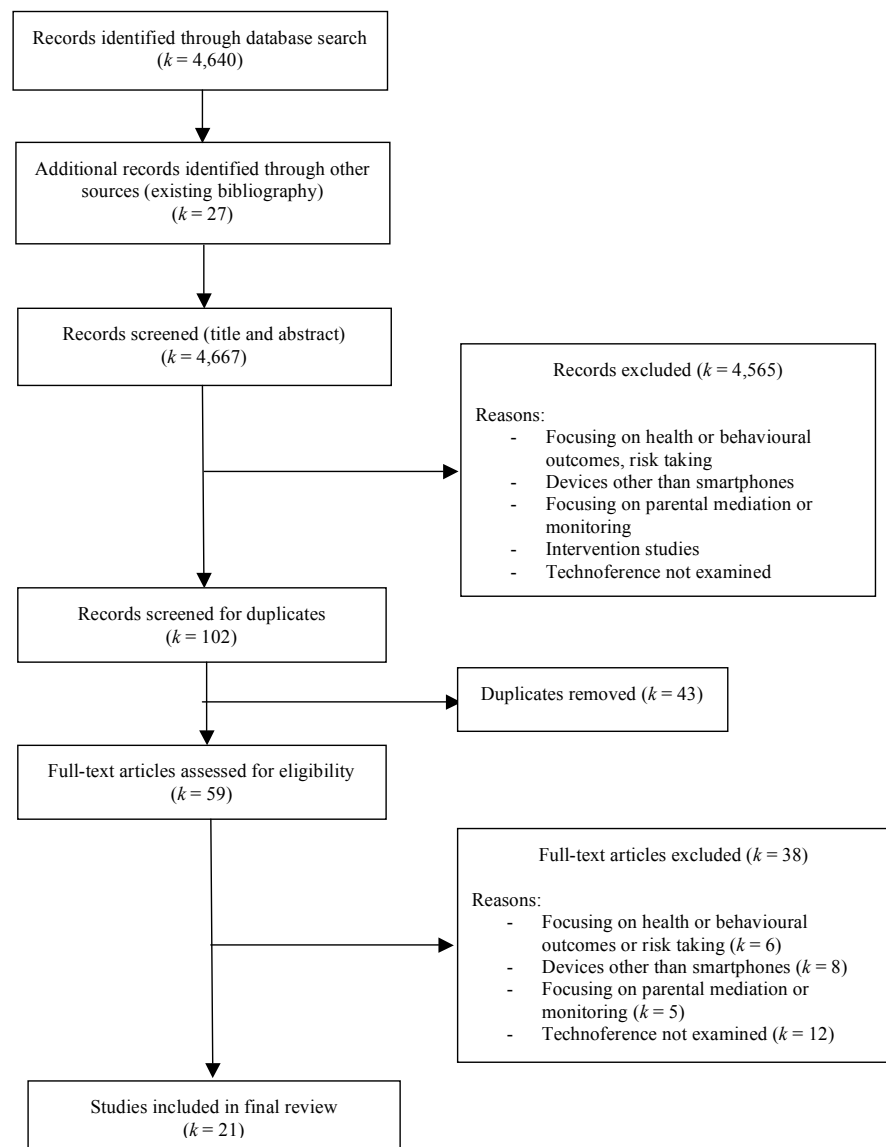


Figure 1. Flow Chart of Literature Search.

the parental smartphone use in the natural family context; (3) studies focusing on outcomes other than parent-child interactions (e.g. internet addiction, obesity, ADHD, behavioral problems, school performance); (4) studies exclusively focusing on digital media other than smartphones; and (5) studies focusing on parental mediation and monitoring, parenting, child rearing, media competency, or pedagogy.

1.4 Quality Assessment

We assessed the quality of the included studies using the Mixed Methods Appraisal Tool (MMAT; Hong et al., 2018). First, the first author categorized the study designs into qualitative ($k = 2$), quantitative non-randomized ($k = 2$), quantitative descriptive ($k = 11$), and mixed methods ($k = 7$) applying the MMAT study design categories. Subsequently, the first author assessed the quality of the studies based on two general quality criteria and five design-specific quality criteria according to the MMAT. A detailed overview of the quality assessment can be found in Table 2 (see electronic supplements).

1.5 Description of Literature

A total of 21 records met all eligibility criteria and were analyzed for this review. Notably, one paper (Kushlev & Dunn, 2019) included two separate studies, which were counted as one publication (hereinafter referred to as Kushlev & Dunn, 2019 (Study 1) or Kushlev & Dunn, 2019 (Study 2)). The 21 studies included scientific peer-reviewed publications ($k = 12$), post-graduate dissertations or Master's theses ($k = 7$), and conference papers ($k = 2$). Among them, 14 studies used survey, self-report or interview data, 6 included observational data, and 5 were based on a (quasi-)experimental design (some studies used mixed methods combining different designs). The sample sizes varied greatly between $N = 12$ participants in in-depth interviews (Johnson, 2017) and $N = 3.000$ participants in an online survey (Nelson, 2016). Most of the studies ($k = 17$) were conducted in North America (USA, Canada), two in European countries, one in Australia, and one in Asia (China) in urban or suburban regions. The studies were published between 2007 and 2019 inclusive.

Eight ($k = 8$) studies were unambiguously classifiable to our age groups given the mean and range of the children's age were within the predefined age ranges (Abels, Vanden Abeele, van Telgen, & van Meijl, 2018; Blackmann, 2015; Golen & Ventura, 2015; Kushlev & Dunn, 2019 (Study 1); Lanette, 2018; Myruski et al., 2018; Stupica, 2016; Ventura & Teitelbaum, 2017). Ten ($k = 10$) studies reported a broad age range that overlapped with two or more of our selected age groups (Ante-Contreras, 2016; Chen, Zhou, & Han 2017; Kellershohn, Walley, West, & Vriesekoop, 2018; Khourouchvili, 2017; Mangan, Leavy, & Jancey, 2018; Nelson, 2016; Palen & Hughes, 2007; Radesky et al.,

2018; Radesky et al., 2015; Stockdale, Coyne, & Padilla-Walker, 2018). In these cases, we always used the lower bound of the reported age range to classify the study (e.g. a study reporting the age range of 5–18 years was assigned to the second age group of 4–6 years). In sum, four ($k = 4$) studies were not classifiable (n/a), because age range was not specified (e.g. < 18 years) or not reported at all (Hiniker et al., 2015; Johnson, 2017; Kushlev & Dunn, 2019 (Study 2); Oduor et al., 2016).

2 Results

We first report results separated by each selected age group (research question 1), and second report results on the potential benefits of parental smartphone use as derived from the review (research question 2). Characteristics of and detailed information on the final set of studies are summarized in Table 3 (see electronic supplements).

2.1 Age Group 1: Infants and Babies (0–3 Years)

We included $k = 11$ studies in this section (Abels et al., 2018; Ante-Contreras, 2016; Chen et al., 2017; Golen & Ventura, 2015; Kellershohn et al., 2018; Mangan et al., 2018; Myruski et al., 2018; Palen & Hughes, 2007; Radesky et al., 2018; Radesky et al., 2015; Ventura & Teitelbaum, 2017). In this age group, a predominant line of research has focused on technofeference during mealtime, a special instance of family quality time. Specifically, in an observational study (Radesky et al., 2015) one third of low-income parents who glanced at least once at their phone during eating showed fewer verbal and non-verbal interactions and displayed less engagement to try new things with their children. However, the parental phone use was not linked to parenting style or overreacting when kids sought attention. Another study found that mothers with a greater smartphone use during mealtime perceived their children as more difficult and they scored lower on a caregiving sensitivity index, as assessed by a semi-structured interview (Radesky et al., 2018). The reasons for parental smartphone use in this age group were habit, disengagement, or boredom (Radesky et al., 2018). During mealtime, 25% of adults who used their smartphone used it to take pictures (Kellershohn et al., 2018). In addition, it was observed that some parents used their phones when they were eating with their children in a restaurant, but most of them (70%) used it when their children were at the restaurant's indoor play area. In a diary study, mothers were asked to report distractions during feeding ("what else, if anything, they were doing while feeding their infants"). A quarter (26%) reported at least one technological distraction, 18% a non-technological distraction, and 56% no distraction at all during the feeding interaction. Higher amounts of technofeference correlated with an unstructured maternal feeding style (e.g. feeding in front of the TV), mothers not noticing

when children have eaten enough, as well as thinking children had a greater appetite (Ventura & Teitelbaum, 2017).

An observational study found a positive correlation between frequency of parental smartphone use and child age (age range of children = 0–5 years), suggesting parental phone involvement was higher when children were older (Abels et al., 2018). The authors found that parental phone involvement was negatively associated with parental responsiveness and children had to increase their effort in gaining their parents' attention. A similar finding was reported when parents were unavailable due to smartphone use; children's bids for attention increased, with a greater negative effect on children with emotion regulation difficulties (Myruski et al., 2018).

Looking at parenting styles, a study found that the amount of hours spent by parents on social media accessed with smartphones was related to an authoritarian parenting style (Ante-Contreras, 2016). Yet, this contradicts another finding in a Chinese sample showing a negative correlation between smartphone use and an authoritarian parenting style (Chen et al., 2017).

With regard to the intensity and duration of smartphone use during parent-child interactions, an observational study found that the majority of parents used their smartphones for less than 5 minutes for typing, talking or camera during a 20 min-observation period at a playground. In 4% of the total observation time, parents ignored children's bids for attention or disengaged from ongoing parent-child interactions due to phone use. The results showed a contrast between observational data and parents' self-reports, as most parents stated in the interview following the observation that they would find it inappropriate to use their phone during child supervision at the playground.

2.2 Age Group 2: Toddlers and Preschool Children (4–6 Years)

We included $k = 4$ studies in this section (Khourchvili, 2017; Kushlev & Dunn, 2019 (Study 1); Nelson, 2016; Stupica, 2016). Khourchvili (2017) reported that the frequency of parental smartphone use was negatively linked with parents' sensitivity towards their infants. Results further suggested that parents with a positive attitude towards smartphones were more competent to decide when it is appropriate to use the devices and when interaction with their child is more important. The findings of a study analyzing parental beliefs and behavior showed that smartphones can possibly have inadvertent, negative consequences on parent-child interactions during family mealtime, as parental happiness and feeling of connection decreased when a smartphone was present on the table (Nelson, 2016). In an experimental study (Stupica, 2016) parental availability and responsiveness were experimentally manipulated to determine the effects on children's athletic performance. Children were asked to run as fast as possible around a softball diamond twice: once while parents were available and responsive and once while par-

ents were unavailable and unresponsive (instruction for parents: "Fully engage your attention in your mobile phone becoming completely engrossed in it while standing in the box turned toward your child. Do not respond to any of your child's attempts to initiate interaction"). Children ran about three seconds faster and were 17% less likely to trip, fall, or false start in the parental available and responsive condition. Furthermore, children ran faster as their parents' availability increased.

In an experimental approach (Kushlev & Dunn, 2019 (Study 1)), participants were asked to maximize ("high use") or minimize their phone use ("low use") during a visit to a children's museum. The manipulation was assessed through use of a parental self-report which indicated whether during the experiment they used their phone more often ("high use") or less often ("low use") than they would normally do. The "high-use" parents reported having a lower quality of attention towards their children and feeling less connected to them compared to the "low use" parents.

2.3 Age Group 3: School-Age Children (7–10 Years)

In this age group, we included $k = 1$ study (Blackmann, 2015). The study examined the association between parental screen time, screen distraction, and parental characteristics (beliefs and demographics). It was found that parental screen time was correlated with screen distraction and this link was mediated by income and education. Further, screen distraction was negatively linked with parental responsiveness towards their children's needs (Blackmann, 2015).

2.4 Age Group 4: Adolescents (11–18 Years)

In this age group, $k = 2$ studies were included (Lanette, 2018; Stockdale et al., 2018). According to Stockdale et al. (2018), 12% of adolescents stated that their parents, when distracted by their smartphone, were "quite a bit" or "a great deal" ignoring them, and 11% said they had difficulties in getting their parents' attention in those situations. Results showed that parental technofence had an influence on adolescents' perceived feeling of parental warmth, which in turn was linked to increased levels of anxiety, depression, cyberbullying, and, unexpectedly, higher levels of prosocial behavior toward family members and strangers. The findings by Lanette (2018) indicated that the mere presence of smartphones had only minimal effects on parental listening qualities and meaningful parent-teen conversations were still possible. Nevertheless, parents and teens felt more distant when a smartphone was present during the conversation.

2.5 Studies not Assignable to the Age Groups

In sum, $k = 4$ studies were not assignable to our predefined age groups, because the age range was not specified or not re-

ported (Hiniker et al., 2015; Johnson, 2017; Kushlev & Dunn, 2019 (Study 2); Oduor et al., 2016). Observing parents at the playground with their school-age children revealed that almost two-thirds of parents used their smartphone less than 5% of their time at the playground (Hiniker et al., 2015). Participants reported being driven by guilt to reduce their smartphone use, but felt incapable of doing so. To counter this, they developed strategies to use their smartphones when the children were safe and occupied (e.g. in bucket swings), or avoided the phone (e.g. locking the phone in the car) in general when with their children. The reported reasons for smartphone use were twice as often related to childcare (such as checking the time, coordinating with others, and taking pictures) as to parent-related activities (such as socializing, work or entertainment). In 32 cases in which parents were observed using their smartphone and children were bidding for parental attention, 56% of the parents did not at all respond to their children's bids for attention (not even looking away from the phone). In contrast, when children were bidding for their parents' attention without smartphone distraction, only 11% of parents did not respond. Notably however, the overall observation period was dominated by parent-child interactions and parents watching their children (Hiniker et al., 2015). The effects on parental attention quality were confirmed by a diary study (Kushlev & Dunn, 2019 (Study 2)), where parents reported that two thirds of parent-child interactions included a smartphone. In the study by Oduor et al. (2016), parents reported that their smartphone use affected parenting and made them feel socially disconnected from their children. Moreover, participants reported feelings of guilt and that they wanted to change their smartphone behavior (Oduor et al., 2016). In addition, adolescents reported that they made parents aware of their disconnection with the real world and that they missed face-to-face connection with their parents (Johnson, 2017).

2.6 Potential Benefits of Parental Smartphone Use

Coming to our second research question, we found that $k = 8$ studies reported any form of benefit of parental smartphone use for parent-child interactions (Chen et al., 2017; Golen & Ventura, 2015; Hiniker et al., 2015; Kellershohn et al., 2018; Kushlev & Dunn, 2019 (Study 1); Mangan et al., 2018; Oduor et al., 2016; Palen & Hughes, 2007). One direct advantage of parental smartphone use for parents reported was entertainment and moments of relaxation while infants were feeding from their bottle (Golen & Ventura, 2015). Furthermore, parents reported the benefit of getting parenting support (e.g. accessing information on parenting via the internet or social media), as well as connecting with their children (Mangan et al., 2018). Chinese mothers reported benefitting from smartphones in terms of connecting with their children on a new level, combining fun, entertainment and learning together, as well as in relation to connecting with other parents. Moreover, smartphone use was associated with lower levels of authoritarian parenting, presumably as smartphones modern-

ize parenting and enable those parents to break away from their own traditional strict Chinese upbringing (Chen et al., 2017).

Other findings suggest that when parents used their phones to enrich the interaction (e.g. seeking information about a topic they were talking about), they reported higher levels of social connectedness (Kushlev & Dunn, 2019 (Study 1)). Similarly, parental smartphone use was perceived as helpful and beneficial when its purpose was useful to family life (e.g. looking up a location, interacting with distant family members; Oduor et al., 2016). Similarly, in interviews parents and caregivers reported positive effects including the use of smartphones as a tool to organize family life (Mangan et al., 2018) and to take pictures (Chen et al., 2017; Hiniker et al., 2015; Kellershohn et al., 2018). Benefits were particularly identified in relation to interaction with distant family members and friends, seeking social support, or feelings of safety in case of emergency (Mangan et al., 2018). Smartphones were also seen by some working parents as a beneficial way of "bringing home to work", in the event they needed to be reached in emergencies (Palen & Hughes, 2007).

3 Discussion

The aims of this systematic review were: (1) to explore the links between parental smartphone use and the quality of parent-child interactions in four different age groups of children; and (2) to review potential benefits of parental smartphone use for these interactions. Regarding our first hypothesis, findings suggest that parental smartphone use was related with the quality of parent-child interactions across all age groups. Specifically, previous research found reduced parental attention and responsiveness towards their children, impaired quality of parent-child interactions or relationships, and decreases in perceived parental warmth associated with parental smartphone use. These are important findings given the omnipresence of smartphones nowadays. That said, the overall amount of parental smartphone use during the various observed parent-child interaction time intervals varied between studies, e.g. 59% of parents used device < 5% (Hiniker et al., 2015) versus 76% of parents for over 80% of observation time (Mangan et al., 2018). This might depend on overall observation time (total time of stay at playground versus first 20 minutes) and observation frame could make a difference, as the initial minutes at the playground may typically be used to organize family life or to take a rest before playing with children again.

The foci and outcomes of the studies differed between the selected age groups. As expected, while studies of younger children predominantly examined indicators of parental sensitivity as the main outcomes, research investigating older children primarily focused on indicators of the parent-child relationship quality (such as feelings of connectedness). Concerning the reasons for smartphone use in the presence of children, parents with younger kids often reported using their phone to connect with others or out of boredom. As rearing infants and toddlers is one of the most emotionally and physically challenging tasks (Nelson, Kushlev, &

Lyubomirsky, 2014), the need of parents to “go online” at times seems understandable. Using the smartphone might serve as a tool for parents to recharge their batteries, while being “off duty”. With older kids, parents stated that they use the phone more often in child-related contexts (e.g. contacting teacher) and the findings on the impact on parent-child interactions appear inconsistent.

Overall, various facets of parent-child interactions have been examined. Among them, mealtime situations were a predominant focus. Parents primarily used their phones when children were not at the table or when children were otherwise occupied. Observations of parents and children during mealtime in a restaurant without technology present revealed that these situations were usually of short duration, including only a few interactions (Kellershohn et al., 2018). Findings suggest that daily meals are a very important contributor to parental well-being and happiness, even in the presence of smartphones (Nelson, 2016). Hence, mealtime appears to be a special quality time for parents in everyday family life. Important to note with regard to family quality time is that it is a critical question who defines which moments belong to quality time. For example, adolescents perceived reduced parental warmth when parents were distracted during a time adolescents themselves defined as quality time, but the parents may not have been aware of this. The definition of quality time is always in the eye of the beholder. Therefore, setting rules for smartphone use during parent-child interactions to safeguard quality time in the family requires consideration of the different family members’ perspectives.

Taken together, we can conclude from the current review that the context of the parents’ smartphone use matters. Important contextual factors include frequency and duration of use, reasons for use, timing (quality time vs. arbitrary moments), and parents’ attitudes towards smartphones. A frequent interpretation of the present findings is that smartphones are not the cause of parent-child interaction difficulties per se, but rather an extended arm of underlying relationship issues already present in analogue (offline) interactions (Radesky et al., 2018). In a similar vein, Abels et al. (2018) concluded that the impact of parental smartphone use could be associated with underlying parental unresponsiveness, rather than with the phone use itself. We deem it necessary to pursue this hypothesis in future research, because new technology is often discussed as an uncontrollable factor invading family life. If further investigations replicate that technofence can be regarded as a reflection of general parent-child relationship patterns, beyond digital media, it would have important practical implications in terms of preventing or reducing negative spillover of parental smartphone use on parent-child interactions.

Within our second research question, we reviewed potential benefits of parental smartphone use for parent-child interactions. In general, the benefits were mostly perceived when parents were relaxed and enjoying themselves, for example when being entertained, connecting with others, or gaining support from digital interactions. These advantages can indirectly be regarded as beneficial for parent-child interactions. Collectively, strikingly few

studies have examined potential benefits of parental smartphone use. This confirms our hypothesis that this focus has been neglected in previous research when compared to the volume of studies on the negative consequences of technofence.

Against this backdrop, it is desirable that more scientific attention is devoted to comprehensively assessing possible positive effects of parental smartphone use on parent-child interactions. For instance, little is known about using smartphones to stay in contact with children when they leave their homes, to care for their relationship via online channels, or to connect on a level that children and adolescents increasingly use with peers. Such an approach would help us gain an adequate awareness in parents and professionals working with families to address this pertinent topic in an appropriate, dispassionate fashion.

3.1 Limitations

Some limitations of the reviewed studies merit consideration. First, given the high heterogeneity of measures and methods, comparability of studies was sometimes difficult to assess. In particular, the term smartphone was not used in all studies. The studies used different terms such as mobile phone or mobile device and it was sometimes unclear if they were referring to online or offline activities. We decided to use smartphone as an overall term, as currently 94% of adults use their smartphones daily. Second, some studies did not provide information about specific age ranges of children, which made it difficult (a) to categorize the studies into the a priori defined age groups, and (b) to examine differential effects between those age groups. Future studies should be more precise when reporting the age of the children, as well as analyze the impact of technofence in relation to children’s age in a more systematic way. Third, the majority of studies were cross-sectional and only a few controlled for a baseline measure of the parent-child interaction or relationship quality. Furthermore, this field lacks experimental studies in particular. These issues make deducing causality impossible and we thus cannot draw definitive conclusions about whether parental smartphone use impairs parent-child interactions. Fourth, this review did not systematically account for potential moderators in the link between parental smartphone use and parent-child interactions. Looking at parental characteristics, the influence of gender, ethnicity and/or other cultural factors, income, and education level i.a. remains unclear and future studies should investigate these potential confounding factors more carefully. Additionally, almost no study considered additional forms of media use in parents (TV, computer etc.) as well as children’s media use, which could possibly amplify the effects. Moreover, smartphones are not the only mode of parental distraction, as several studies also assessed other distractions (siblings, preparing dinner, etc.; Kushlev & Dunn, 2019). Future experimental studies might address whether technofence has different effects on parent-child interactions than non-technological distraction.

3.2 Conclusion and Future Directions

With these caveats in mind, the current findings add to our understanding about the impact of parental smartphone use on parent-child interactions. Given that this research field is still in its infancy, more knowledge is needed about: (1) parental user habits and absorption level; (2) underlying mechanisms and moderating factors; (3) parental and child attitudes towards smartphone use in the family setting; and (4) potential benefits for family interactions and relationships. Families have to find adequate ways of dealing with new technology in everyday life, which inevitably affects the nature of their daily interactions. It is a new form of navigation through close relationships in analogue and digital spheres. Therefore, we think that it is high time to examine more thoroughly how parents can model for their kids a well-balanced and relationship-compatible handling of smartphones in day-to-day life.

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Author contributions

BK conducted the systematic literature search, screened studies for eligibility, coded the studies, and wrote the manuscript.
MZ supported the literature search, supervised screening and coding of studies, and wrote the manuscript.

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Electronic supplements

Table 1. Keywords for Literature Research

Parent terms	Child terms	Smart device terms	Parent-child interaction terms
Parent*(s), parental, mother*(s), maternal, mom*(s), father*(s), paternal, dad*(s)	Child, children (child*), adolescents	Smartphone, smart phone, smart device, mobile phone, tablet, laptop, screen time, portable screen	Interaction, relationship (quality), (quality) time, sensitivity, communication, responsivity, responsiveness, conflict

Table 2. Quality Assessment of Included Studies

Author(s)	Category ^a for Study Design	Quality Criteria ^b						
		S1	S2	1	2	3	4	5
Abels et al. (2018)	4	+	+	+	+	+	+	+
Ante-Contreras (2016)	4	+	+	+	+	+	-	?
Blackmann (2015)	4	+	+	+	+	+	+	+
Chen, Zhou, & Han (2017)	1	+	+	+	?	+	-	?
Golen & Ventura (2015)	5	+	+	+	+	+	?	+
Hiniker, Sobel, Suh, Sung, Lee, & Kientz (2015)	5	+	+	+	+	?	+	?
Johnson (2017)	1	+	+	+	+	?	?	+
Kellersohn (2018)	4	+	+	+	?	+	+	?
Khourochvili (2017)	4	+	+	-	-	+	+	+
Kushlev & Dunn (2019; Study 1)	3	?	+	+	?	+	+	+
Kushlev & Dunn (2019; Study 2)	4	+	+	+	+	?	?	+
Lanette (2018)	5	+	+	+	+	?	-	?
Mangan et al. (2017)	5	+	+	+	+	+	?	+
Myruski et al. (2018)	3	+	+	+	+	+	?	+
Nelson (2016)	4	+	+	+	?	?	-	+
Oduor et al. (2016)	5	+	+	+	+	?	-	+
Palen & Hughes (2007)	5	+	+	+	?	?	+	+
Radesky et al. (2018)	4	+	+	?	+	+	+	+
Radesky et al. (2015)	4	+	+	+	?	?	+	+
Stockdale et al. (2018)	4	+	+	+	+	+	+	+
Stupica et al. (2016)	4	+	+	+	+	+	?	+
Ventura & Teitelbaum (2017)	5	+	+	+	+	+	+	+

Note: Quality of studies were assessed using the Mixed Methods Appraisal Tool (MMAT; Hong et al., 2018). ^aStudy design was assigned to the MMAT design categories: 1 = Qualitative; 2 = Quantitative randomized controlled trials; 3 = Quantitative non-randomized; 4 = Quantitative descriptive; 5 = Mixed methods ^bTwo general quality criteria (S1 and S2) and five design-specific quality criteria (1 to 5) were assessed: according to the MMAT; + = criterion is met; - = criterion is not met; ? = criterion is not assessable.

Table 3. Characteristics and Detailed Information of Included Studies (k = 21)

Author(s)	Kind of Publication	Country of Study	Sample (N)	Age of Children (Age Group for Review)	Study Design (MMAT ^a)	Main Outcome (Measure)	Key Findings
Abels et al. (2018)	Peer-reviewed paper	Netherlands	N = 25 caregiver-child dyads	M = 26.3 months (age group 1)	Quantitative descriptive	Behavioral coding of caregivers' behavior, children's bid for attention, caregivers' responsiveness (self-developed observational rating system)	Overall responsiveness ($X^2 = 27.3$, $\beta = -1.11$, $SE \beta = 0.22$, Nagelkerke $R^2 = .14$, $p < .001$, $OR = 0.32$), timeliness of the response ($X^2 = 28.3$, $\beta = -1.9$, $SE \beta = 0.38$, Nagelkerke $R^2 = .19$, $p < .001$, $OR = 0.15$), and strength of the response ($X^2 = 10.8$, $\beta = -1.2$, $SE \beta = 0.43$, Nagelkerke $R^2 = .04$, $p = .007$, $OR = 0.32$) were negatively predicted by caregivers' engagement with their phone. No relation was found with the emotionality of the response ($X^2 = 0.8$, $\beta = -15.5$, $SE \beta = 7289.5$, Nagelkerke $R^2 = .01$, $p = .998$).
Ante-Contreras (2016)	Thesis	USA	N = 167 parents	0–4 years (age group 1)	Quantitative descriptive	Online survey using the Parent-child attachment and parenting style questionnaire ("Provincial Assessment of Parenting Styles"; Biletchi et al., 2013)	There was one statistically significant relationship between any of the social media usage variables and the parenting variables, that is, a positive relationship between hours of social media usage and a high score on authoritarian parenting techniques ($r(167) = .157$, $p < .049$). 75% of parents reported to use social media up to three times a day during parent child in contrast to 2% stated to never use social media during supervision of their children. However, only 10% of the parents believe their attention is inhibited while using the device.
Blackmann (2015)	Thesis	USA	N = 93 parents and caregivers	M = 8.42 years (age group 3)	Quantitative descriptive	Parenting behaviors: bonding, discipline, education, general welfare and protection, responsiveness, sensitivity, negativity ("Parent Behavior Importance Questionnaire-Revised PBIQ-R"; Mowder, 2009).	There was a positive relationship between parental screen time and parental screen distractions among caregivers ($r = .36$, $p < .001$). Distracted parents showed less responsiveness to their children ($r = -.210$, $p = .043$) compared to screen viewing parents. The correlation between parents screen time and their screen distractions were moderated by education level (R^2 change = $.205$), $F(2, 87) = 13.47$, $p < .001$) and annual household income ($b = -.583$, $SE \beta = .149$, $t(86) = 3.91$, $p = .000$).
Chen, Zhou, & Han (2017)	Peer-reviewed paper	China	N = 23 mothers	Range = 1–6 years (age group 1)	Qualitative	Mothers' perception and interpretation of the role of smartphone (tablet) in daily communication and interaction with their children (interviews; interpretative phenomenology analysis IPA)	Chinese mothers have a mixed feeling toward the role of smartphone and tablet playing in their parenting practices. According to those participants, the smartphone and tablet both help and impair their communications and interactions with their children. There are both direct and indirect benefits of using smartphones for parenting.

eTable 3. continuation

Golen & Ventura (2015)	Peer-reviewed paper	USA	N = 24 infants (girls), N = 32 mothers, (N = 21 mothers were over-weight or obese)	Range = 14.4 ± 7.1 weeks (age group 1)	Mixed methods	Mothers' distraction in feeding interactions (diary report and "Infant Behavior Questionnaire-Revised Very Short Form IBQ-R"; Peterson, Waldie, Mohal, Reese, Atatoo Carr, Grant, & Morton, 2017)	For the majority of the feedings (52%), mothers did a variety of additional activities, including watching TV, laying down or sleeping, using a phone, doing housework reading, using a mobile device, traveling (e.g., the baby was in a stroller or car seat), listening to music, using the computer, and eating. During almost one-third (32.4%) of feedings, mothers reported using technological distractors. For the remaining 48% of feedings, mothers reported interacting with their infants or that they did not do anything else during the feeding.
Hiniker, Sobel, Suh, Sung, Lee, & Klientz (2015)	Conference paper	USA	N = 466 parents	< 10 years (age group n/a)	Mixed methods	1) Field note codes from observations covered nine areas: child-caregiver interaction, children's attempts to interrupt adults, caregiver position, supervision style, phone activities, nonphone activities, balancing phone use with child needs, behavior just before and after phone use, and children's activity during phone use; 2) Code categories drawn from interviews: beliefs about the purpose of the playground, parenting style, concerns about phone use while caring for children, and benefits of phone use	Parents reported a low usage of phones but high feeling of guilt. Some parents felt more available to their children, when they were on their phone. 28% of caregivers thought that phone use while supervising children was acceptable as long as their child was safe. 40% of parents thought phone use should be related to being at the park and 40% of parents would like to decrease their use.
Johnson (2017)	Thesis	USA	N = 12 parents	< 18 years (age group n/a)	Qualitative	Attitudes, practices, and opinions regarding the smartphone use in the presence of their children (semi-structured interview by author)	Parental smartphone use affected the lives of study participants. Participants who seemed to lack awareness of these costs in their own life identified the same costs. Five primary themes emerged: (1) Disengagement, (2) concern for future, (3) change in social norms, (4) boundaries, and (5) cognitive dissonance.
Kellerstohn et al. (2018)	Thesis (published)	Canada	N = 300 families with 450 children	Range = 2–12 years (age group 1)	Quantitative descriptive	Behavioral coding of family dining behavior (direct, unobtrusive and structured observation)	The food ordering process was rapid (< 6 min), during which personal technology use was minimal, and adult/child interactions were perfunctory. Visits averaged 53 min, and only 18 min on average was spent eating. Families were observed using the fast food restaurant as a "third place" (home away from home) for many activities other than eating food. In-restaurant family behaviors included frequent use of technology (40% of children/70 % of adults), use of the indoor play area (65% of children/33min of play) and child engagement with a toy (53 % of children/10min of play).

Table 3. continuation

Khourouchvili (2017)	Thesis	Canada	N = 19 mothers	Range = 4–11 months (age group 2)	Quantitative descriptive	1) Caregiver sensitivity and infant responses (modified Face-to-Face Still-Face Procedure FFSF; Tronick et al., 1978); 2) Behavioral coding based on a modified classification of the behavior categories by Mesman et al. (2009): Presence or absence of gaze, positive, neutral or negative/ distressed affect	Caregivers who used technology more frequently were less sensitive with their infant when absorbed with their mobile phones ($p < .001$), measured by the increase of disengagement behaviors from control ($M = 2.27$, $SD = 5.49$) to the smartphone condition ($M = 32.61$, $SD = 11.59$). In contrast, the better the caregivers' ability to divide attention, the less sensitive they were ($t(14) = -2.61$, $p = .02$, $r = -0.57$). Further, the higher caregivers' total MTUAS scores (their reported technology usage and attitudes toward technology), the less positive affect and gaze toward their infant was demonstrated during the caregiver divided attention phase ($t(14) = -2.26$, $p = .04$, $r = -0.52$).
Kushlev & Dunn (2019)	Peer-reviewed paper	USA	Study 1: N = 200 parents; Study 2: N = 114 parents	Study 1: Median = 5 years (age group 2); Study 2: < 19 years (age group n/a)	Study 1: quantitative non randomized; Study 2: quantitative descriptive	Social connectedness (adapted two items from the "Social Connectedness Scale"; Lee, Draper, & Lee, 2001)	Study 1: Frequent phone use led parents to feel more distracted, which in turn impaired feelings of social connectedness ($t(197) = 5.11$, $p < .001$) and the meaning that parents derived when spending time with their children ($t(195) = 2.12$, $p = .035$) compared to low phone use group. Study 2: Smartphones distracted parents from reaping a sense of social connection when spending time with their children as the study found indirect effects of phone use through attention on both general social connectedness, $b = .08$, $p = .017$, and social connectedness with children, $b = .06$, $p = .017$.
Lanette (2018)	Thesis	USA	N = 200 (100 parent-child dyadic pairs)	M = 16.04 years (SD = 2.24). (age group 4)	Mixed methods	Conversation quality ("Intrinsic Motivation Inventory"; Miska, Cheng, Genevieve, & Yuan, 2014)	The mere presence or absence of smartphones did not affect parents- or teens-reported conversation quality or partner listening. The mere presence of mobile phones did overlap with a decline in parents reported conversation closeness ($F(4, 87) = 2.27$, $p = .07$).
Mangan et al. (2017)	Peer-reviewed paper	Australia	N = 50 parents in observation, N = 25 parents in interviews	Range = 0–5 years (age group 1)	Mixed methods	Behavioral coding of no parent-child interaction, adult leaves, interaction equipment interaction, independent play, talking-, play-, and touch-interaction (observational rating system "The Parent/ Caregiver and Child Interaction Scale" (adapted from Hiniker et al., 2015)	76% (N = 38) of the parents/caregivers used their mobile device, with usage time extending to 17.2 min of the 20 min-observation period. Text-/type-related mobile device use was most often used (69.6%), followed by voice-related (23.7%), and camera-related smartphone use (6.7%). The 25 interviewed parents/caregivers beliefs on mobile device use were centred on three themes: (1) Diversity of smartphone use, (2) child relationships and smartphone use, and (3) the physical environment and smartphone use.

Table 3. continuation

Myruski et al. (2018)	Peer-reviewed paper	USA	N = 50 mother-infant-dyads	Range = 7.20–23.60 months, (SD = 4.74) (age group 1)	Quantitative non randomized	Behavioral coding of negative affect, positive affect, toy engagement, engagement with mother, social bid, room exploration (modified Still Face Paradigm SFP; Tronick et al., 1978).	During maternal smartphone use infants showed more negative affect ($t(49) = 2.98, p = .004; F(2, 96) = 5.67, p = .005, \eta_p^2 = .11$) and less positive affect during still-face task. Infants showed the most need for attention and social bids ($t(49) = 6.76, p < .001$) during still face task. More frequent reported smartphone use was associated with less positive affect ($\beta = -.35, t(49) = -2.37, p = .022$), less recovery (i.e., engagement with mother, ($t(49) = -17.64, p < .001$), room exploration ($t(49) = -11.37, p < .001; F(2, 96) = 117.83, p < .001, \eta_p^2 = .71$) during reunion, even when adjusting for temperament.
Nelson (2016)	Thesis	USA	N = 3000 parents	Range = 5–18 years (age group 2)	Quantitative descriptive	Parental and overall happiness (self-developed questionnaire)	Daily family meals were positively associated with parents reporting being “very happy”. Parents strongly desired the emotional energy that results from parent-child interactions during the family meal and these positive results may be inhibited by the mere presence of electronic devices, if this ritual does not take place daily. Thus, in the presence of electronic devices, regular family meals may not be enough to produce the meaningful interactions that produce wellbeing.
Oduor et al. (2016)	Conference paper	Australia	N = 20	< 18 years (age group n/a)	Mixed methods	Family dynamics when smart-phone was used during interaction (self-developed survey, diary and interview)	Family members became upset when others did non-urgent activities on their phones in the presence of others. In some cases, people developed strategies to provide a greater sense of activity awareness to warfare the problem. Smartphone usage was perceived as beneficial by providing a mechanism for needed disengagement from family members.
Palen & Hughes (2007)	Peer-reviewed paper	Denmark/ USA	N = 5 families	Range = 3–13 years (age group 1)	Mixed methods	Parental mobile phone use, (self-developed interview and experimental sampling method, ESM)	In presence of their children, parents did not have their phones with them. When at home, parents were less likely even to be aware of whether their phone was on/off. While around younger children, parents used their phone to connect with other adults. Parents used their phones to stay in touch with adolescents.
Radesky et al. (2018)	Peer-reviewed paper	USA	N = 301 caregiver-child dyads	Range = 3–4 years (age group 1)	Quantitative descriptive	Parent-child eating encounters (observational rating of videotaped home mealtimes and structured laboratory-based protocol); Semi structured interview to assess richness of perceptions, caregiving sensitivity, intensity of involvement, acceptance of the child, child difficulty, and parenting reflectivity (“Working Model of the Child Interview WMCII”; Zeanah & Benoit, 1995)	During the family mealtime, 47 (24.1%) mothers actively used a smartphone at least once, while during the structured eating protocol, 44 (22.6%) mothers used a device. Higher child difficulties (OR = 1.65), lower sensitivity (OR = 0.67) and lower richness of perceptions (OR = 0.72) were associated with smartphone use during mealtimes.

Table 3. continuation

Radesky et al. (2015)	Peer-reviewed paper	USA	N = 225 mother-child dyads	Range = 0–6 years (age group 1)	Quantitative descriptive	Bob and Tom's Method of Assessing Nutrition (BTMAN), Mother-Child Eating Interaction Protocol (self-developed)	Mothers with mobile device use had significantly fewer verbal interactions (11.1 vs. 14.1, $p = 0.03$) with their children than mothers who had no or negligible use during the eating protocol, particularly during presentation of halva (2.3 vs 3.7, $p = 0.03$), the most unfamiliar of the foods presented. In addition, mothers with mobile device use made significantly fewer total encouragements (8.8 vs. 12.3, $p = 0.03$) and fewer encouragements regarding unfamiliar foods (5.0 vs. 7.7, $p = 0.02$). Maternal use of mobile devices was associated with 20% (95% CI: -3%, 37%) fewer verbal and 39% (95% CI: 4%, 61%) fewer nonverbal interactions during the eating protocol.
Stockdale et al. (2018)	Peer-reviewed paper	USA	N = 1072 adolescents	Range = 10–20 years (age group 4)	Quantitative descriptive	Adolescents' technofence and ratings of their parents' technofence (modified version of "The Technofence Scale"; McDaniel & Coyne, 2014); Parental warmth (three items from the "Parenting Styles and Dimensions Questionnaire-Short Version PSDQ"; Robinson, Mandelco, Olsen, & Hart, 2001)	Parental technofence was related to less parental warmth ($\beta = -0.35, p < .001$), cyberbullying ($\beta = 0.20, p < .001$), anxiety ($\beta = 0.28, p < .001$), depression ($\beta = 0.24, p < .001$), civic engagement ($\beta = 0.19, p < .001$), prosocial behavior towards strangers ($\beta = 0.22, p < .001$), and family members ($\beta = 0.20, p < .001$), mediated through parental warmth. Adolescent technofence was directly related to cyberbullying ($\beta = 0.28, p < .001$), anxiety ($\beta = 0.13, p < .001$), depression ($\beta = 0.21, p < .001$), prosocial behavior towards stranger ($\beta = -0.16, p < .001$), family members ($\beta = -0.28, p < .001$), and civic engagement ($\beta = -0.12, p = .003$). Adolescent technofence was not related to parental warmth ($p = .10$)
Stupica (2016)	Peer-reviewed paper	USA	N = 50 parents	M = 6.8 years; SD = 2.72 (age group 2)	Quantitative descriptive	Behavioral coding of parental behavior: sensitivity and response (self-developed observational rating system)	Parental sensitivity and responsiveness predicted how fast a child would run around a baseball base, as children ran 3.66 seconds faster ($SE = .75, p < .001$, Cohen's $d = 1.409$). Children's times decreased as parental sensitivity increased ($\beta = -1.51, SE = 0.71, p = .04$), and children's times increased as parental harshness increased ($\beta = 1.70, SE = .73, p = .02$).
Ventura & Teitelbaum (2017)	Peer-reviewed paper	USA	N = 75 mothers	< 6 months (age group 1)	Quantitative descriptive	Distraction while feeding (self developed diaries)	Among the reported 43% of feeding distractions, 26% involved technological distractors. Compared to mothers with only one child, multiparous mothers reported greater levels of any distraction during feeding ($\beta = 18.27, SE = 7.43, p = .02$). Mothers of racial/ethnic minorities reported greater levels of technological distraction ($\beta = -13.56, SE = 4.93, p = .008$), tended to show a laissez faire feeding style ($\beta = 6.83, SE = 2.75, p = .02$), and perceived their infants to have lower food responsiveness ($\beta = -13.66, SE = 3.62, p < .001$) and greater appetite ($\beta = 11.37, SE = 2.64, p < .001$).

Note: *Study design was assigned to the MMAT design categories by Hong et al. (2018).