

TECHNOLOGY AND CAREGIVER-CHILD INTERACTION:
THE EFFECTS OF PARENTAL MOBILE DEVICE USE ON INFANTS

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Abstract

Despite the increasing prevalence of mobile devices in social settings, little is known about their effect on caregiver-child relationships. This study examines what happens when a caregiver becomes engrossed with a mobile device while in the presence of her infant, creating a divided attention context similar to that demonstrated in Tronick *et al.*'s (1978) *Face-to-Face Still-Face paradigm*. A modified version of this paradigm was administered to nineteen caregiver-infant dyads in Toronto, resulting in notable similarities in dyadic behaviours to the original paradigm. It was also found that caregivers who used technology more frequently were less sensitive with their infant when absorbed with their mobile phones. Surprisingly, the more attention difficulties that caregivers reported, the *more* sensitive they were toward their infants, while the *better* caregivers' ability to divide their attention, the *less* sensitive they were. Caregivers' decreased engagement with their infants is worrisome, as caregiver sensitivity predicts children's socioemotional development.

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Technology and Caregiver-Child Interaction:

The effects of parental mobile device use on infants

Introduction

With the recent rise of communication technology use worldwide, mobile devices have become increasingly prevalent in social settings. Several studies have suggested that their constant use may negatively affect many areas of relational functioning, including dyadic relationships (e.g. Przybylski & Weinstein, 2012; 2013). Although cellular phones are also a means by which to be more available and feel closer to others (Leung & Wei, 2000), little is known about the effect of their ubiquitousness in the context of caregiver-child relationships. Indeed, caregivers may be less sensitive to their children when distracted by a cellular phone.

The current study examines what happens when a caregiver becomes engrossed with a mobile device while in the presence of her infant, creating a divided attention context that may yield dyadic interactions similar to those first demonstrated in Tronick *et al.*'s (1978) *Face-to-Face Still-Face paradigm* experiments (FFSF). In that context, facial unresponsiveness was found to lead to “intense wariness and eventual withdrawal” of the infant (Tronick, Als, Adamson, Wise, & Brazelton, 1978, p. 1), and is known to be a stressor for young infants (Cohn & Tronick, 1983). The study further explores caregivers' attitudes toward media and technology, their reported technology usage, their attentional capacity (as measured by a self-report measure and short divided attention task), and how these factors may relate to caregiver sensitivity and infant responses during the withdrawal task.

Mobile Technology Use

The use of telephones for interpersonal conversation began in the late 1920s (Rakow & Navarro, 1993). Women's domestic uses of this technology were largely for safety and shopping;

however, AT&T began to encourage social uses of the telephone in the late 1920s (Fischer, 1988). Women's social and physical location in the home, and their duties to care for their home and children, were key determinants for women's telephone use (Rakow, 1986). Indeed, one early study showed that women used the telephone for household matters and community work (Rakow, 1992).

In the United States, the cellular phone industry only began in 1983, but has grown rapidly since, with almost 5.3 million Americans owning cellular telephones by 1991 (Rakow & Navarro, 1993). Women who began using cellular phones could take part in "remote mothering" by being available to their children by cellular phone, and "keeping the family in contact with each other" (Rakow & Navarro, 1993, p. 153). Warnings about cell phone were already apparent in the 2000s, with suggestions that individuals may rely less on their own judgment, memory, and reflection due to the "constant availability of external communication partners" (Geser, 2006, p. 5). Consequently, individuals may be less likely to develop certain "social competencies" such as reacting appropriately to unpredictable events (Fortunati, 2000).

With the advent of the BlackBerry in 1999 and the iPhone in 2007, mobile technologies have become increasingly omnipresent across daily living contexts in a digital era. Notably, the number of cell phone users across the world totaled one billion by 2001 (International Telecommunications Union, 2002). Over the years, the use of mobile devices has extended from just a few locations in the home to active usage across various settings, including the kitchen, living room, and bathroom (Kawsar & Brush, 2013). Social media use increased from 7% in 2005 to 86% in 2016 for U.S. adults aged 18 to 29, and from 6% in 2005 to 80% in 2016 for adults aged 30 to 49 (Pew Research Centre, 2017). Similarly, internet usage increased from 70% in 2005 to 99% in 2016 for U.S. adults aged 18 to 29, and from 61% in 2005 to 96% in 2016 for

adults aged 30 to 49 (Pew Research Centre, 2017). College students for example are thought to spend upwards of 9 hours on their cell phones each day (Roberts, Yaya, & Manolis, 2014). While the existing literature sometimes portrays adolescents as excessive technology users, caregivers are ascribed the responsibility of monitoring (Álvarez, Torres, Rodríguez, Padilla, & Rodrigo, 2013; O’Keeffe and Clarke-Pearson, 2001; Ortiz, Green, & Lim, 2011; Sonck, Nikken, & de Haan, 2012; Valcke, Bonte, Wever, & Rots, 2010; van den Eijnden et al., 2009). However, parents of children have also been found to use technology heavily: 91% own a mobile phone and two-thirds are part of social network websites (Lenhart et al., 2011). It seems that, in today’s society, the many available communication technologies are a means for individuals to maintain social connectedness and community membership (Wei & Lo, 2006).

The increased use of mobile digital devices has however raised concerns in various contexts. For example, cell phone use has been found to negatively affect cognitively demanding tasks such as driving, by interfering with the allocation of attention (Patten, Kircher, Östlund, & Nilsson, 2004; Strayer, Drews, & Johnston, 2003). The resulting divided attention disrupts those aspects of driving that require greater attentional capacity (Horrey & Simons, 2007). In fact, engaging in a cell phone conversation can decrease driving performance more than being legally drunk (Strayer, Drews, & Crouch, 2006). Furthermore, talking on a cell phone can hinder users’ likelihood of acknowledging other people and their awareness of different stimuli in the environment (Hyman, Boss, Wise, McKenzie, & Caggiano, 2010). Notably, the *mere presence* of mobile communication technology can interfere with forming interpersonal relationships (Przybylski & Weinstein, 2012). These findings suggest that communication technologies may be a source of divided attention, as their presence can divert attention away from current

interpersonal interactions toward a myriad of other interests and concerns. Ultimately, this divided attention context might affect the development of healthy relationships.

In romantic relationships, partner “phubbing” (partner phone snubbing), or the extent to which one uses his/her cell phone in the presence of his/her relationship partner, has become a common occurrence (Coyne, Stockdale, Busby, Iverson, & Grant, 2011; Lenhart & Duggan, 2014). Indeed, 71% of a sample of 143 females involved in romantic relationships reported that cell phones interrupted their interactions with their partners “sometimes”, “often”, “very often”, or “all the time” (McDaniel & Coyne, 2014, p. 14). Roberts and David (2016) found that partner “phubbing” led to decreased relationship satisfaction, and consequently, had a negative impact on life satisfaction and depression. Several studies have examined the impact of technology use on family relationships as well. Over the last two decades, mobile phones have been increasingly used to maintain connections between family members (Beech et al., 2004; Neustaedter, Harrison, & Sellen, 2013; Sellen, Hymans, & Eardley, 2004) and can even strengthen bonds between family members (Wei & Lo, 2006). Further, some studies suggest that mobile technologies are instruments for inter-generational communication (Ribak, 2009; Yarosh, Denise Chew, & Abowd, 2009) and for relationship satisfaction with parents (Miller-Ott, Kelly, & Duran, 2014). Another study found positive effects of cell phones when used by adolescents to seek social support from parents, but these devices negatively affected parent-adolescent relationships when used by parents as a means to monitor and track activity (Weisskirch, 2011).

Surprisingly, caregiver mobile device use, a technological environment to which an increasing number of young children are exposed, is understudied. For parents of children aged 12 to 17, Internet usage increased from 80% in 2004 to 87% in 2006, and leveled at 87% in 2011 (Macgill, 2007; Lenhart et al., 2011). Further, parents with children under the age of 18 years are

more likely to have used the Internet and to own a cell phone than are adults without minors (Allen & Rainie, 2002; Lenhart, 2010). In addition, it is more probable for married couples with children to own technological devices than it is for married couples without children, non-married couples, and singles (Kennedy, Smith, Wells, & Wellman, 2008).

A limited amount of research has suggested a possible detrimental effect on children when caregivers are engaged with mobile phones (Radesky et al., 2014; Steiner-Adair & Barker, 2013; Turkle, 2011). Radesky *et al.* (2014) conducted 55 public, anonymous observations of caregivers and their children (who were approximately 0 to 10 years of age) eating in fast food restaurants in the Boston area from July 2013 through August 2013. The researchers found the caregivers' degree of absorption with a mobile device to be the dominant theme of the caregiver-child relationship. Caregiver behaviours ranged from having the device on the table to almost constant absorption with the device (in 16, or close to one third, of the observations). Child responses ranged from entertaining themselves to increasing demands for attention, which were often answered negatively by the parents. In another study, caregivers were found to be involved in a range of mobile phone usage and non-usage while watching their children at playgrounds (Hiniker et al., 2015). Notably, use of mobile devices resulted in delayed responding by the caregiver to children in need of attention. Golden (2015) states that, "while parents generally report that they are only on their mobile devices for a few seconds at a time, video evidence shows that they can be absorbed for upwards of 3 minutes at a stretch" (p. 102). This shows that caregivers are more distracted when engaging with their devices, and are less in tune with their infants. As evidenced from these and earlier findings, digital communication devices and social media are increasingly common and popular among caregivers, and may have unintended consequences in the context of child rearing.

Caregiver Sensitivity

Currently, there is no reliable evidence to suggest that caregivers' engagement with mobile communication technology is detrimental to caregiver-child relationships. However, it is not unreasonable to query whether mobile devices might significantly interfere with caregivers' attention when interacting with very young children, resulting in a divided attention context. Caregivers' excessive distraction by mobile devices warrants concern for their ability to appropriately attend and respond to their infants, a feature of parenting also known as caregiver sensitivity. Ainsworth (1967) was the first to conceptualize maternal sensitivity, describing it as a prompt and appropriate response to signals that are perceived and interpreted correctly. Sensitive responding is characterized by maternal care that is attuned to the baby's state and mood; thus, sensitive dyadic interactions happen according to the baby's timing. It is timely, responsive interaction and not simply care that is of most importance, with healthy interactions resulting in mutual delight in the exchanges between mother and child.

Ainsworth (1969) proposed four dichotomous 9-point scales to define maternal care: Sensitivity-Insensitivity; Cooperation-Interference; Acceptance-Rejection; Accessibility-Ignoring. These scales were developed by closely examining the behaviours from Ainsworth's narrative records (Ainsworth, Blehar, Waters, & Wall, 1978). The Sensitivity-Insensitivity scale refers to the mother's "prompt and appropriate responsiveness to Baby's accurately perceived signals and communications" (Bretherton, 2013, p. 465), and is considered to be the most important dimension since sensitive mothers were also found to have higher ratings for cooperation, acceptance, and accessibility (Meins, 1999). The Cooperation-Interference scale is based on the mother's attitude toward her baby as an autonomous person, and the extent to which her initiations of interaction interrupt her infant's ongoing activity. Ratings of Acceptance-

Rejection are based on the balance between the mother's positive and negative feelings about her baby. Finally, Accessibility-Ignoring is evaluated by how physically and psychologically accessible the mother is to her infant (Bretherton, 2013). At the high end of the scales are mothers who are sensitive to their infant's signals, are cooperative with their infant, are accepting of their baby and of being a mother, and are accessible to their child. In contrast, the low scale points represent mothers who seem preoccupied with themselves and are more arbitrary in their behaviours. Mothers in the middle range are characterized as "inconsistently sensitive, mildly interfering, ambivalently accepting, and inconsistently accessible" (Bretherton, 2013, p. 466). These scales can be used to illustrate differences in the sensitivity of caregivers and in the ways they respond to their infant's cues.

Contingent responses from caregivers can include behaviours that: "mirror the infants' affect (Stern, 1985), respond to the foci of their attention (Bornstein et al., 1992), and reflect on the subjective state underlying the infant's behavioural signals (Fonagy & Target, 2000)" (Haley & Stansbury, 2003, p. 1535). These caregiver responses can serve as external sources of regulation for the infant (Tronick, 1989), and thus a lack of such responses may result in infant stress (Weinberg & Tronick, 1996). Indeed, when caregivers are appropriately sensitive to infants' affective cues, infants begin to develop self-regulatory capabilities to cope with longer periods of unresponsiveness, such as the "still-face" episode of the FFSF (Conradt & Ablow, 2010). It is important to note however, that some infants may have learned that their caregivers will not provide an adequate sensitive response during distress and these infants too may demonstrate self-regulation. Nevertheless, caregivers are considered to be key modulators of infant emotion regulation and are expected to provide synchronous interaction (Field, 1994; Stoller & Field, 1982). However, when the caregiver is unresponsive, infants' emotions become

dysregulated and synchrony is no longer achieved. Ultimately, this affects infants' behaviour, emotions, and physiological state.

Importantly, sensitivity has been closely linked to caregiver-infant attachment patterns (Bowlby, 1951, 1988; Ainsworth, 1963, 1967). For example, when parents successfully help the infant to regulate after a period of distress, this has been shown to lead to attachment security (Jeffrey F. Cohn, Campbell, & Ross, 1991). Ainsworth and colleagues (1978) reported a strong relationship between maternal sensitivity and infants' attachment security as measured by the Strange Situation procedure. Furthermore, many attachment theorists have posited that sensitivity is the main predictor of attachment security (Sroufe & Waters, 1977; Egeland & Farber, 1984; Harris, 1999; Isabella, 1993; Pederson & Moran, 1996), although this has been challenged by more recent studies (Goldsmith & Alansky, 1987; Schneider-Rosen & Rothbaum, 1993; Atkinson et al., 2000). Interestingly, quality of attachment has also been predicted by infants' behaviour alone. Koulomzin et al. (2002) predicted infants' secure vs. avoidant attachment at 12 months of age from their behaviour during face-to-face interaction. Future secure infants spent more time looking at their mother, showed a greater range of affect, and sustained gaze longer. In contrast, future avoidant infants demonstrated more tactile behaviors, more looking away, and sustained gaze at mother only if involved in self-touch/mouthing. In light of such studies, several aspects of maternal sensitivity have emerged as playing a key role in predicting infant attachment outcomes: "(1) stimulating while infants gaze at the mothers, and holding back on stimulating while infants gaze avert, facilitates infant ability to use looking away as a coping mechanism...; (2) maternal tendency to increase stimulation following infant distress is an aspect of maternal insensitivity; (3) contingent maternal coordination with infant behaviour that is 'midrange' in degree...predicts attachment security; and (4) maternal

facilitation of repair following disruption predicts attachment security.” (Beebe & Steele, 2013, p. 592).

Maternal sensitivity has also been linked to developmental outcomes (Lohaus, Keller, Ball, Voelker, & Elben, 2004). For example, maternal sensitivity and mother-infant attachment security have been shown to predict children’s adaptive functioning over time, as well as social development (e.g., Berlin, Cassidy, & Belsky, 1995; Fagot, 1997), personality development (e.g., Sroufe, Carlson, & Shulman, 1993; Urban, Carlson, Egeland, & Sroufe, 1991), cognitive development (e.g., Jacobsen & Hofmann, 1997; van IJzendoorn, Dijkstra, Bus, & IJzendoorn, 1995), and the incidence of behavioural difficulties (e.g., Carlson, 1998; Lyons-Ruth, Easterbrooks, & Cibelli, 1997). Specifically, contingent parent responsiveness plays a particularly large role as it leads to a sense of self-efficacy in the infant (Brazelton, Koslowski, & Main, 1974) and promotes social (e.g., Legerstee & Varghese, 2001), cognitive (e.g., Tamis-LeMonda, Bornstein, & Baumwell, 2001), and emotional development (e.g., Kochanska & Coy, 2002). Further, maternal sensitivity in early and middle childhood, in addition to infant attachment security, both significantly predicted children’s adjustment in middle childhood (Stams, Juffer, & van IJzendoorn, 2002). As evidenced by these findings, highly sensitive caregiving may provide many benefits for a child’s development, such as effective emotion regulation and attachment security, while low caregiver sensitivity can be problematic.

Caregiver Attentional Capacity

Given the divided attention context created by a caregiver’s engagement with a cell phone in the presence of his or her infant, it may also be important to examine caregivers’ attentional capacity as it relates to their level of sensitivity in this context. Namely, caregivers’ ability to be aware of their infant’s cues, interpret them correctly, and respond promptly and

appropriately may be associated with their attentional profiles (Banks, Ninowski, Mash, & Semple, 2008; Murray & Johnston, 2006; Watkins & Mash, 2009). There currently exists a gap in the literature when it comes to the effect of adult ADHD symptoms on family functioning, specifically parenting (Banks et al., 2008). Nevertheless, it has been suggested that adults with ADHD struggle with consistent parenting, monitoring their child's activities, managing their child's behaviour, and setting limits (Dixon, 1995; Weiss, Hechtman, & Weiss, 2000; Murray & Johnston, 2006). In one study with ninety-nine mothers of 6-month-old infants, findings showed that even mothers with sub-clinical levels of ADHD symptoms had an increased risk of parental cognitions and behaviours that could negatively influence their child's development (Watkins & Mash, 2009). Consequently, caregivers who report more severe attention difficulties may be more likely to display lower levels of sensitivity toward their infants in contexts where there are multiple demands on their attention. For example, such caregivers might potentially struggle with maintaining adequate awareness of their infant's cues in a situation where engagement with a mobile device competes with their child's bids for attention.

Face-to-Face Still-Face Paradigm

The innovative work of Tronick, Heidelise, Adamson, Wise, and Brazelton in 1978 provides a clear demonstration of the potential effects of extreme lack of caregiver sensitivity. The researchers designed an experimental structured face-to-face interaction called the Face-to-Face Still-Face paradigm (FFSF), which creates a stressed state in infants due to caregiver unresponsiveness. The FFSF is based on the understanding that the goal of early face-to-face interactions between caregivers and infants is the attainment of mutual regulation, which lays the foundation for the development of effective self-regulation (Conradt & Ablow, 2010). The Mutual Regulation Model (MRM) (Gianino & Tronick, 1988; Tronick, 2007) proposes that the

caregiver and infant have an interactive goal of achieving mutual regulation and the capacities by which to achieve that purpose. To attain this reciprocity, they regulate the interaction together through their interactive behaviours, mainly their affective displays. However, reciprocity is not always achieved for reasons that include mistimed behaviour, misreading of signals, and differences in immediate goals. These “normal disruptions” or mismatches act as motivation for the infant to adjust to them or to change them using his or her interactive abilities (Gianino & Tronick, 1988). Therefore, when caregivers “check out” of an interaction with their child by becoming completely unresponsive during the FFSF paradigm, there is opportunity to examine infants’ interactive and regulatory abilities in response to such a stressor (Haley & Stansbury, 2003; Conradt & Ablow, 2010).

The FFSF paradigm consists of three phases: (1) a typical play interaction between mother and infant; (2) a “still-face” episode, during which the mother is instructed to remain still and unresponsive; (3) a “reunion” phase in which the mother resumes the usual social interaction with her infant (Tronick et al., 1978). Each of these conditions lasts approximately 2 or 3 minutes (Weinberg & Tronick, 1996). The unnatural interaction that occurs between mother and infant during the still-face condition has been found to be stressful for 3- to 6-month-olds (Cohn & Tronick, 1983; Field, Vega-Lahr, Scafidi, & Goldstein, 1986; Toda & Fogel, 1993). Infants typically become distressed in response to the contradictory information that is conveyed (Tronick et al., 1978): the mother’s position and eye contact invite social interaction while her neutral face denies it (Gianino & Tronick, 1988). The FFSF thus permits the examination of caregiver sensitivity in response to both infant stress (during reunion) and non-stress (during play).

As a result of their stress experience during the FFSF, infants exhibit a wide variety of observable behaviours throughout the phases of the experimental context. At first, infants are likely to signal caregivers by smiling and orienting toward them to re-establish reciprocity, but increase crying and protest behaviours when caregivers remain unresponsive (Mesman, van IJzendoorn, & Bakermans-Kranenburg, 2009). The classic still-face effect involves a decrease in gaze and positive affect and an increase in negative affect, from the first phase to the still-face phase, with partial recovery occurring during reunion (Adamson & Frick, 2003; Tronick et al., 1978).

During the still-face phase, infants may display self-regulatory behaviours, including self-soothing, distraction, and facing the caregiver (Braungart-Rieker, Garwood, Powers, & Notaro, 1998). In addition to behavioural reactions, infants have also been found to respond physiologically to the still-face condition through an increase in heart rate (Haley & Stansbury, 2003; Moore & Calkins, 2004; Weinberg & Tronick, 1996), elevated skin conductance (Ham & Tronick, 2006), and a drop in vagal tone (Weinberg & Tronick, 1996). During reunion, infants often exhibit attention seeking and avoidance behaviours (Kogan & Carter, 1996; Miller, McDonough, Rosenblum, & Sameroff, 2002; Rosenblum, McDonough, Muzik, Miller, & Sameroff, 2002). Weinberg & Tronick (1996) further characterize the reunion phase by the presence of a carryover of negative affect from the still-face episode, an increase in fussiness and crying, and the return of positive affect.

The FFSF paradigm has been used extensively (Adamson & Frick, 2003; Braungart-Rieker et al., 1998; Cohn & Tronick, 1987; Field, Healy, Goldstein, & Guthertz, 1990; Field et al., 1986; Fogel, Diamond, Langhorst, & Demos, 1982; Kisilevsky et al., 1998; Lamb, Morrison, & Malkin, 1987; Liu, Yang, Fang, Snidman, & Tronick, 2013; Melinder, Forbes, Tronick, Fikke,

& Gredeback, 2010), demonstrating the versatility of this protocol. Further, the procedures reported in Weinberg and Tronick (1996) have been used in various studies yielding findings for different age-groups (e.g., 3, 6, and 9 months), gender, maternal characteristics (e.g., depressed, substance using), and coding schemes (e.g., Infant Regulatory Scoring System, Infant Caregiver Engagement System) (Tronick, 2003). The exploration of infants' behavioural and physiological reactions to the "still face" stressor has enhanced our understanding of infants' "sensitivity to violation of social contingency, the affective structure and organization of early social interactions, and theories about self-regulation versus mutual regulation of affect" (Haley & Stansbury, 2003). Importantly, a child's experience of stress early in life is largely influenced by caregiving and is linked to their ability to regulate emotion later in life (Loman & Gunnar, 2010). In fact, successful regulation after distress can promote physiological and behavioural regulation (Conradt & Ablow, 2010). To date, the FFSF paradigm has been widely used to study the quality of caregiver-infant interactions and infant behaviours during caregiver unresponsiveness making it suitable for examining sensitive caregiving in a variety of contexts that may be analogous to the still-face.

Maternal sensitivity and infant still-face response

The relationship between caregiver sensitivity, and infant responses to the stress of the still-face, has been examined in fourteen studies that are reviewed by Mesman *et al.* (2009) in their meta-analysis. In one study, maternal sensitivity during the typical play phase predicted more positive behaviours in 6-month-old infants during the still-face phase (Tronick, Ricks, & Cohn, 1982). Braungart-Rieker, Garwood, Powers, and Wang (2001) found similar results in 4-month-old infants. Another study demonstrated that 3-month-old infants looked at their mothers longer during the still-face episode if their caregivers showed more positive affect during play

(Carter, Mayes, & Pajer, 1990). Yet another study showed that 6-month-old infants whose mothers exhibited more interactive behaviours (e.g., mirroring and game-playing) during the play phase displayed more positive affect during the still-face episode (Lowe, Handmaker, & Aragón, 2006).

With respect to re-engagement, Kogan and Carter (1996) found that maternal sensitivity during play was associated with more infant regulation and less avoidant and resistant behaviour during the reunion phase. Infants of more emotionally available mothers were more likely to rely on the mother to regulate their emotions (decrease negative affect and resume normal interaction). Specifically, maternal sensitivity predicted infants' reengagement style: infants of more sensitive mothers reengaged by looking, smiling, positively vocalizing, or reaching. In contrast, infants of less sensitive mothers reengaged with avoidance (ex. gaze aversion), resistance (ex. continuous negativity), or both. Similarly, infants of mothers exhibiting anxiety during reunion showed less positive affect and more negative affect, avoidance, and resistance during this episode (Rosenblum et al., 2002). In a study of maternal interactive behaviour *prior* to the FFSF (Tarabulsky et al., 2003), maternal sensitivity was found to relate to decreased negative affect during the still-face condition, and this association was stronger for infants with a difficult temperament. In two more recent studies, contingent maternal responses were associated with more positive affect in infants across all the FFSF phases (Lowe et al., 2012), and with an increase in social bids during the still-face condition (Mcquaid, Bibok, & Carpendale, 2009).

In a culture that is characterized by the constant intrusion of technology, environments in which caregivers are intensely focused on a mobile device in the presence of their infants provide a unique naturalistic setting in which to examine the effects of caregiver sensitivity. In fact, there are blatant similarities between a context of divided attention in which caregivers are

engaged with a digital device while interacting with their infant, and the dyadic interactions first demonstrated within the FFSF paradigm. Indeed, infants may experience stress when their caregivers are distracted by cell phone activities in their daily lives. Given past findings on the negative effects of intense technological engagement in adults and adolescents, similar issues may arise between caregivers and their young children.

Current Study

Nineteen 4- to 11-month-old infants and their caregivers were recruited from Toronto, Ontario. A modified version of the FFSF paradigm (Tronick et al., 1978) was administered in a quasi-experimental setting, consisting of three phases: a “typical face-to-face” interaction (dyadic engagement) with the caregiver (2 minutes); a “caregiver divided attention” interaction with the caregiver engaged in answering text messages sent by the researcher while in the presence of her infant (5 minutes); a dyadic interaction without interference from a mobile device (caregiver re-engagement) (2 minutes). Infants’ and caregivers’ behaviours were coded at 2-second intervals based on a modified classification of the behaviour categories identified by Mesman *et al.* (2009) in their meta-analysis. In addition, caregiver technology use was assessed with the Media and Technology Usage and Attitudes Scale (MTUAS; Rosen, Whaling, Carrier, Cheever, & Rokkum, 2013). Lastly, caregiver attentional capacity was measured using a self-report measure that asked caregivers about the frequency and severity of attention symptoms [Adult ADHD Self-Report Scale Version 1.1 (ASRS-v1.1) - Screener; Kessler et al., 2005] and a task that measured caregivers’ divided attention abilities [Paced Auditory Serial Addition Task (PASAT); Gronwall, 1977], to examine associations that may enhance our understanding of caregivers’ sensitivity with their infants while engaged with mobile technology.

Objectives and Hypotheses

Objective 1

The first objective of this study was to examine whether digital media use adversely affects caregiver-child interaction; specifically, whether caregivers are less sensitive to their children while engaged with a mobile device, thereby yielding dyadic interactions that show features similar to those first demonstrated in Tronick et al.'s (1978) Face-to-Face Still-Face paradigm experiments. This study's experimental context (*the cell phone engagement protocol*) required a caregiver's intensive engagement with a mobile device in her child's presence.

Hypotheses

Similarities would be demonstrated between the original FFSF paradigm and this study's *cell phone engagement protocol*.

The *cell phone engagement protocol*:

1A. would impair caregiver sensitivity and result in disengagement from their infant: caregivers would more frequently display negative or neutral affect while gazing away from their infant, similarly to the caregiver disengagement behaviours displayed in the FFSF paradigm

1B. would result in patterns of behaviour in infants that are similar to those described in the original FFSF studies:

- i. infants would more frequently display reactions of distressed or neutral affect while gazing away from their caregiver when the latter was engaged with a mobile device after interacting as usual

- ii. the frequency with which infants attempted to engage caregivers across the three phases would differ: infants' re-engagement would show a lag much like in the original FFSF paradigm

Objective 2

The second objective of this study was to determine whether there is a relationship between the frequency and severity of attention difficulties reported by caregivers on the Adult ADHD Self-Report Scale Version 1.1 (ASRS-v1.1) – Screener (Kessler et al., 2005), and caregivers' behaviour patterns, namely intensity of disengagement from the infant during the experimental divided attention task in which caregivers are asked to respond to text messages on a cell phone.

Hypothesis 2

The greater the severity of attention difficulties reported by a caregiver, the less sensitive her caregiving behaviours would be during the divided attention task (caregiver divided attention phase), as demonstrated by more frequent displays of negative or neutral affect while responding to competing demands.

Objective 3

The third objective of this study was to examine the relationship between caregivers' performance on a divided attention task (Paced Auditory Serial Addition Task) (PASAT; Gronwall, 1977) and the sensitivity of their behaviours during the caregiver divided attention phase of the *cell phone engagement protocol*.

Hypothesis 3

There would be a relationship between caregivers' performance on the PASAT and the sensitivity of their behaviours during the caregiver divided attention phase of the *cell phone engagement protocol*. Specifically, the higher caregivers' scores on the PASAT, the more

sensitively they would behave with their infants during the divided attention phase of the *cell phone engagement protocol*, as measured by the frequency of their engaging behaviours (positive or neutral affect while gazing toward infant).

Objective 4

The final objective of this study was to investigate the relationship between caregiver attitudes toward technology and their reported technology use, as measured by the Media and Technology Usage and Attitudes Scale (MTUAS; Rosen et al., 2013), and their level of engagement with their infant during the caregiver divided attention phase of the experimental protocol.

Hypothesis 4

Caregivers' attitude toward technology and their report of technology usage based on Media and Technology Usage and Attitudes Scale (MTUAS; Rosen et al., 2013) scores would be related to the intensity of disengagement from their infant while engaged with a mobile device.

Specifically, the higher their technology use and/or the more positive caregivers' attitude toward technology, the easier it would be for caregivers to comply with the competing demands by researchers in the *cell phone engagement protocol*.

Method

This study was reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conformed to the standards of the Canadian Tri-Council Research Ethics guidelines.

Participants

Nineteen caregiver-infant dyads were recruited from Toronto, Ontario and the Greater Toronto Area through social media postings (on Facebook, Kijiji, and the BUNZ phone app), community postings (flyers put up at local cafés and Ontario Early Years Centres), and snowball sampling (current participants recruiting other participants from among their acquaintances). Twelve of these nineteen caregivers were assessed for their attentional capacity. Infants ranged from 4 to 11 months of age ($M = 8.1$ months), with 13 females and 6 males. All caregivers were mothers with from 18 to 39 years old ($M = 31.4$ years). Of the nineteen mothers in this sample, seven were of European descent, three were East Asians/Pacific Islanders, two were South Asians, one was Southeast Asian, one was South American, and five were of mixed ethnicity; two had completed some college/university, twelve held a college or university degree, and five held a graduate degree.

Setting and Equipment

Data were collected at participants' homes, their friends' homes, or at the Infant and Child Mental Health Lab at York University. Each home visit was conducted by a graduate researcher and an undergraduate research assistant, or by two undergraduate research assistants. The experimental set-up was modeled after the original FFSF procedures (Field et al., 1986; Stoller & Field, 1982). Caregivers were asked to position their infant in an infant seat on a table or on the floor, at eye level with the caregiver who was seated facing the child, approximately 18

inches (46 centimeters) away. A camera recorded the profiles of the caregiver and infant from a distance of approximately 6 feet (1.8 metres). Videos were later transferred onto a desktop or laptop computer for analysis with VLC Media Player.

Procedure

Caregivers were greeted by the researchers and asked to make themselves and their infants comfortable in the study area. The researchers provided a brief verbal overview of the procedure and then obtained written consent from the caregivers.

The *cell phone engagement protocol* was administered after the caregiver and infant were appropriately positioned. The caregiver was first asked to play with her infant as she usually would at home while keeping her cell phone nearby. The researcher then asked the caregiver to check her phone and follow the instructions that would be sent to her by the second researcher. The text messages prompted caregivers to answer a series of questions (see Appendix A). Finally, the caregiver was again asked to engage in a typical play interaction with her infant.

Following the modified FFSF protocol, the caregiver completed the demographic questionnaire and the MTUAS. Next, she completed the ASRS-v1.1 – Screener (Kessler et al., 2005). Finally, the researcher administered the PASAT (Gronwall, 1977) to the caregiver. This task required the caregiver to provide verbal responses to stimuli, and the researcher recorded these answers on a specified form. The researchers then debriefed the caregivers and explained the objectives of the research study.

Modified Face-to-Face Still-Face Procedure (FFSF; Tronick et al., 1978). The cell phone engagement protocol (modified FFSF procedure) consisted of three phases: a “typical face-to-face” interaction (dyadic engagement) with the caregiver (2 minutes); a “caregiver divided attention” interaction with the caregiver engaged in answering text messages sent by the

researcher while in the presence of her infant (5 minutes); a dyadic interaction without interference from a mobile device (caregiver re-engagement) (2 minutes).

Paced Auditory Serial Addition Test (PASAT; Gronwall, 1977). The PASAT has been used to assess attention, concentration, working memory, and speed of information processing (Gronwall, 1977; Levin, Benton, & Grossman, 1982; Levin et al., 1987), and is one of the most frequently used tests for assessing attentional processing (Gordon & Zillmer, 1997). Studies have reported split-half reliability of over 0.90 (Egan, 1988) and test-retest reliability of 0.93-0.97 (McCaffrey et al., 1995) for the PASAT. In this test, a random series of numbers from 1 to 9 are delivered with decreasing inter-stimulus intervals in each subsequent series. The participant is asked to add each new digit to the one immediately before it and state the sum out loud. For the purpose of the current study, two trials with 61 items each were administered, the first with an inter-stimulus interval of 3 seconds (PASAT-3”), and the second with an inter-stimulus interval of 2 seconds (PASAT-2”). Thus, the PASAT served as a type of “divided attention task” for caregivers.

The PASAT was presented on a CD in order to control the rate of stimulus presentation. The final test scores were determined by the number of correct sums given out of the maximum 60 for the PASAT-3” and the PASAT-2”, respectively, and by combining the scores of both parts for an overall total score. Administration time was approximately 6 minutes. All caregiver responses were noted on the PASAT Record Form by the researcher.

Measures

Demographic Questionnaire. The demographic questionnaire consisted of 16 questions about caregivers’ age, education level, racial background, current employment, marital and economic statuses, and their child’s developmental history. After caregivers responded to the

first six questions sent by text (Appendix A), the researcher responsible for sending text messages began to send the questions of the demographic questionnaire one-by-one through text messaging, until the caregiver divided attention phase was over.

Media and Technology Usage and Attitudes Scale (MTUAS; Rosen et al., 2013). The MTUAS is a 60-item scale comprised of questions about caregivers' general media usage (44-item subscale) and attitudes toward technology use (16-item subscale), with a total of 15 subscales. The usage subscale has caregivers rate how often they engage in each of the listed activities (e.g., using a mobile phone, using any technological device, searching the Internet, using social media) with a frequency scale of 1 (never) to 10 (all the time). The items in the attitudes subscale explore positive and negative attitudes, anxiety, and dependence toward technology, as well as preferences for task switching (e.g. "I like to finish one task completely before focusing on anything else"). The responses are reported on a scale of 1 (strongly disagree) to 5 (strongly agree). Overall, higher caregiver scores on the scales represent higher daily media and technology usage and more positive caregiver attitudes towards technology. The subscales of the MTUAS demonstrate strong reliability and validity (Rosen et al., 2013). In this study, the total MTUAS scale showed high internal consistency ($\alpha = .915$), as did the usage subscale ($\alpha = .903$) and the attitudes subscale ($\alpha = .808$).

Adult ADHD Self-Report Scale (ASRS) Version 1.1 (Kessler et al., 2005). The ASRS Version 1.1 (or ASRS-v1.1 Symptom Checklist) is an instrument developed by the World Health Organization in 2005, and is comprised of 18 questions assessing the recent frequency of DSM-IV Criterion A symptoms of adult ADHD. Each question asks how often a symptom has occurred over the past 6 months, on a scale ranging from 1 = "never", 2 = "rarely", 3 = "sometimes", 4 = "often", and 5 = "very often". The ASRS has been validated using the US

National Comorbidity Survey Replication (NCSR) cohort (Kessler et al., 2005). In a representative sample of health plan members in the U.S., internal consistency reliability of the ASRS Screener ranged from 0.63-0.72, and test-retest reliability was between 0.58 and 0.77 (Kessler et al., 2007). Furthermore, the ASRS has shown high internal consistency and high concurrent validity with standard clinician ratings on the ADHD Rating Scale (Adler et al., 2006). In this study, the total ASRS scale showed adequate internal consistency ($\alpha = .708$).

Behavioural Coding

Both caregiver and infant behaviours were coded, by trained and reliable coders, for each of the nineteen dyadic interaction videos (IRR = 0.827). Two reliable coders double-coded every fourth video for inter-rater reliability. Caregiver and infant behaviours were coded at 2-second intervals throughout each of the three phases of the *cell phone engagement protocol*, based on a modified classification of the behaviour categories identified by Mesman, van Ijzendoorn and Bakermans-Kranenburg (2009) in their meta-analysis. Their review included 39 studies that “represented the most common use of the Still-Face Procedure in terms of its procedures and that reported on normative samples” (Mesman et al., 2009, p. 136). Their coding of the behaviours reported in these studies indicated the presence or absence of gaze (at mother’s face, or face and body), positive affect, negative affect, and neutral affect as outcomes of the FFSF. Therefore, the authors of the current study chose these behavioural categories for their coding of both caregiver and infant behaviours. To better capture the level of engagement of each member of the dyad, the following modifications were made: sub-categories were added within “gaze”; one new behavioural category was added for each dyad member (self-soothing for infants, contact without gaze for caregivers); an “unknown” category was added for each type of outcome due to poor video quality that interfered with the accurate coding of facial expressions. Thus, the infant

behaviours coded in the current study were: gaze toward (looking at the *mothers's face, any other body parts of the mother, or cell phone*); gaze away; gaze unknown; positive affect (e.g., smiling, positive vocalizations); neutral affect (not positive and not negative); distressed affect (e.g., crying, protesting); affect unknown; and self-soothing (i.e., engaging with an object while gazing away from the mother). The caregiver behaviours coded in the current study were: gaze toward (looking at the infant); gaze away; gaze unknown; positive affect (e.g., smiling, leaning in, talking to infant); neutral affect; negative affect (e.g., negative comments, frowning, sighing); affect unknown; and contact without gaze (*verbal* [i.e., mother engaging verbally with her infant while her gaze is fixated on her cell phone] or *physical* [i.e., mother engaging physically with her infant while her gaze is fixated on her cell phone]). Videos were coded by recording in a spreadsheet which of the above behaviours were exhibited by the infants and caregivers during each 2-second time interval.

Table 1: Infant and caregiver behaviours coded in the *cell phone engagement protocol*.

| Infant Behaviours | |
|-----------------------------|--|
| Gaze Toward | <i>Mother's Face</i> <i>Any other body parts of the mother</i> <i>Cell phone</i> |
| Gaze Away | |
| Gaze Unknown | |
| Positive Affect | |
| Neutral Affect | |
| Distressed Affect | |
| Affect Unknown | |
| Self-Soothing | |
| Caregiver Behaviours | |
| Gaze Toward | |
| Gaze Away | |
| Gaze Unknown | |
| Positive Affect | |
| Neutral Affect | |
| Negative Affect | |
| Affect Unknown | |
| Contact Without Gaze | <i>Verbal</i> <i>Physical</i> |

Data Cleaning. The behaviours of both infants and caregivers were grouped into four umbrella categories of gaze and affect, representing a range from most negative engagement between infant and caregiver to the most positive engagement. Four categories of infant behaviours were included in the analyses: (1) distressed affect and gaze away; (2) neutral affect and gaze away; (3) neutral affect and gaze toward the mother's face or any other body parts of the mother; and (4) positive affect and gaze toward the mother's face or any other body parts of the mother. Similarly, four categories of caregiver behaviours were analyzed: (1) negative affect and gaze away; (2) neutral affect and gaze away; (3) neutral affect and gaze toward infant; and (4) positive affect and gaze toward infant. At every one-second interval of the cell phone engagement protocol, a numerical value between 1 to 4 (representing the labeled categories

above) was assigned to both infant and caregiver coded behaviours, resulting in paired coordinates of dyadic behaviour. Any infant and caregiver behaviours that did not fit within the above categories were excluded from SSG analysis for the purpose of this study. The values recorded within each of the four caregiver and infant categories in each phase were then tallied by category, and converted into proportions by dividing the total frequency of the given behaviour by the total number of behaviours noted during a given phase of the cell phone engagement protocol. This conversion compensated for the differences in interaction length between the three phases.

State Space Grid Analysis

State Space Grid (SSG) methodology can be used to evaluate a dyadic system's recovery from a perturbation (e.g. the still-face manipulation), the nature of the recovery process, and how recovery relates to the dyad's typical dynamic characteristics (Sravish, Tronick, Hollenstein, & Beeghly, 2013). The SSG method has been used to study dyadic behaviour in various populations, including parent interactions with their older children (e.g. Lichtwarck-Aschoff, Hasselman, Cox, Pepler, & Granic, 2012) and peer-peer interactions (Dishion, Nelson, Winter, & Bullock, 2004).

Caregiver and infant behaviours were plotted using modified dynamic systems *state space grids* using *Gridware 1.15a* (Lamey, Hollenstein, Lewis, & Granic, 2004). Grids are two-dimensional and each axis represents a member of the dyad, and respective behavioural states for each (Hollenstein, 2012). The four caregiver behaviour categories were plotted along the x-axis of the grids, from (1) "most negative engagement" through (4) "most positive engagement". The four infant behaviour categories were plotted along the y-axis, and also ranged from (1) "most negative engagement" through (4) "most positive engagement". This resulted in sixteen cells on

each state space grid, with each cell representing all the possible dyadic states attainable by the dyadic system. Each point on a grid represented a coordinate of the form (caregiver behaviour, infant behaviour). For example, a point at (2,3) suggests that the caregiver displayed neutral affect and was gazing away, while the infant displayed neutral affect but was gazing at the mother's face or a body part of the mother during the one-second moment in time. The upper right-hand quadrants of each grid represent the most positive (most mutually engaged) interactions between an infant and caregiver, while the lower left-hand quadrants represent the most negative interactions (most disengaged) between infant and caregiver. A separate grid was created for each of the three phases of the *cell phone engagement protocol*, depicting the dyadic interaction patterns over the 120 seconds of the dyadic engagement phase, the 300 seconds of the caregiver divided attention phase, and the final 120 seconds of the caregiver re-engagement phase by the mother and her infant.

Results

Hypothesis 1: Similarities Between the Original FFSF Paradigm and a *Cell Phone*

Engagement Protocol

The modified dynamic systems state space grids created with Gridware 1.15a are shown in Figure 1, and give a general impression of the dynamic of the dyads as they moved from the dyadic engagement phase (DY-ENGMT), through the caregiver divided attention (CG-DA) phase, and finally to the caregiver re-engagement (CG-RE-ENGMT) phase. Only the second half (minute 2) of the dyadic engagement phase is displayed, as it was observed that infants spent much of the first minute getting oriented to their new surroundings and the researchers. The first half (minute 1) of the caregiver re-engagement phase is demonstrated, to highlight the “carryover effect” shown in the original FFSF experiments. The visual patterns apparent from the graphs are further supported by repeated measures ANOVAs using RStudio Version 0.99.491, which include analyses of the full time intervals of each phase.

To conduct the necessary statistical analyses in RStudio, the proportion of infant engaging behaviours (or “infant engagement”) was defined as the mean of the proportions, based on total coded behaviours during a given time unit (see Table 2), of the two most engaging infant behaviours: *neutral affect and gaze toward caregiver’s face or other body part/3* and *positive affect and gaze toward caregiver’s face or other body part/4*. Similarly, the proportion of infant disengaging behaviours (or “infant disengagement”) was defined as the mean of the proportions of the two least engaging infant behaviours: *distressed affect and gaze away/1* and *neutral affect and gaze away/2*. Analogous combinations were created for caregiver behaviours. The proportion of caregiver engaging behaviours (or “caregiver engagement”) was defined as the mean of the proportions, based on total coded behaviours during a given time unit (see Table 2),

of the two most engaging caregiver behaviours: *neutral affect and gaze toward infant/3* and *positive affect and gaze toward infant/4*. Similarly, the proportion of caregiver disengaging behaviours (or “caregiver disengagement”) was defined as the mean of the proportions of the two least engaging caregiver behaviours: *negative affect and gaze away/1* and *neutral affect and gaze away/2*. In the statistical analyses, caregiver and infant disengagement were labelled as negative behaviour (“negbeh”), and caregiver and infant engagement were labelled as positive behaviour (“posbeh”), respectively.

Table 2: Total Infant and Caregiver Behaviours Across Each Phase

| | DY-ENGMT | CG-DA | CG-RE-ENGMT |
|--------------------|----------|-------|-------------|
| Participant | | | |
| 1 | 91 | 61 | 70 |
| 2 | 88 | 115 | 58 |
| 3 | 36 | 157 | 68 |
| 4 | 68 | 176 | 56 |
| 5 | 73 | 279 | 102 |
| 6 | 63 | 152 | 24 |
| 7 | 82 | 183 | 79 |
| 8 | 83 | 199 | 99 |
| 9 | 89 | 250 | 101 |
| 10 | 94 | 263 | 101 |
| 11 | 49 | 249 | 96 |
| 12 | 33 | 208 | 84 |
| 13 | 60 | 296 | 96 |
| 14 | 96 | 232 | 96 |
| 15 | 89 | 220 | 96 |
| 16 | 80 | 294 | 98 |
| 17 | 102 | 233 | 78 |
| 18 | 82 | 232 | 105 |
| 19 | 93 | 270 | 91 |

Overall, caregivers displayed significantly more engaged behaviours (3 and 4) during the dyadic engagement phase ($p < .001$); shifted toward significantly more disengaged behaviours (1 and 2) during the caregiver divided attention phase as compared to the first phase ($p < .001$); then

reverted to significantly more engaged behaviours during the caregiver re-engagement phase ($p < .001$). Meanwhile, infants showed significantly more engaging behaviours (3 and 4) during the dyadic engagement phase ($p < .001$); significantly more of the disengaging behaviours (1 and 2), but also a large amount of engaging behaviours (3) during the caregiver divided attention phase ($p = .38$); and presented slightly more disengaging behaviours (1 and 2) ($p = .19$) and slightly less positive behaviours (3 and 4) ($p = .19$) during the caregiver re-engagement phase as compared to the behaviour pattern in the dyadic engagement phase. These behavioural patterns suggest that the quality of dyadic interactions was most negative (least engaging) during the caregiver divided attention phase, when caregivers were required to divide their attention between their infant and answering text messages on their mobile device (Figure 1).

In addition to obtaining a visual representation of the overall dynamic of the dyads as they progressed through each phase of the experiment, further statistical analyses were conducted to explore significant differences in caregiver and infant behaviours across the phases. Proportions of all behaviours were converted into percentages for the purpose of analysis. Using a Repeated Measures ANOVA, it was found that there was a significant effect of phase on caregiver engagement [$F(1.47, 26.52) = 118.62, p < .001, ges = .79$], caregiver disengagement [$F(1.47, 26.43) = 120.31, p < .001, ges = .79$], infant engagement [$F(1.70, 30.59) = 27.06, p < .001, ges = .33$], and infant disengagement [$F(1.70, 30.61) = 26.56, p < .001, ges = .32$]. Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated; therefore, a Greenhouse-Geisser correction was used and all reported results are sphericity-corrected. GES (generalized eta squared) values represent the percentage of variability in a particular behaviour that is accounted for by phase. Figure 2 juxtaposes caregiver and infant behaviour (engagement vs. disengagement) across the three phases of the *cell phone engagement*

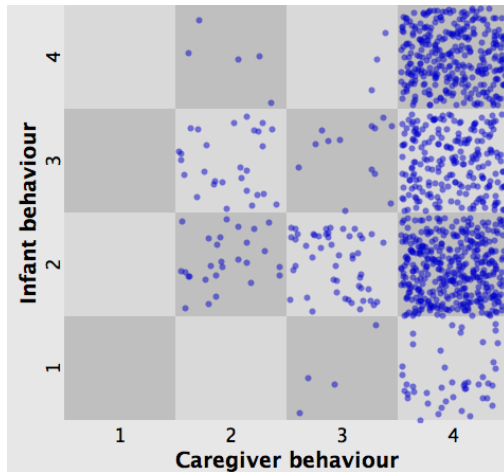
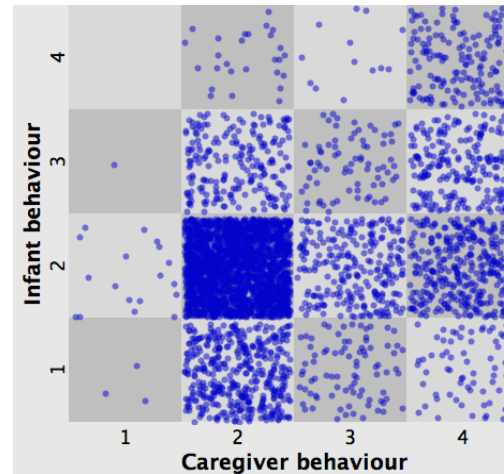
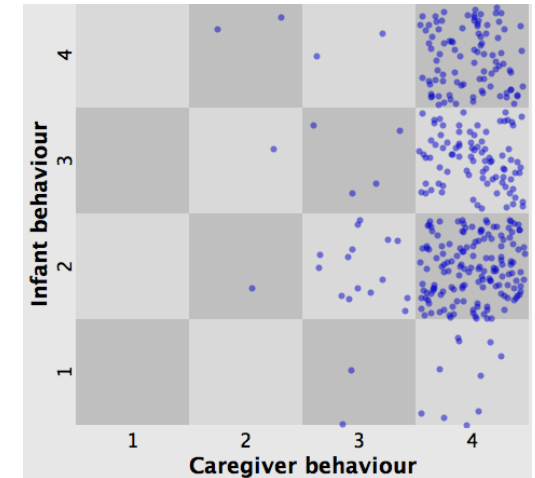
Caregiver Re-Engagement Phase**Caregiver Divided Attention Phase****Dyadic Engagement Phase**

Figure 1. Caregiver-infant interactions of all dyads. The behaviours rank on a scale of 1 to 4, from most negatively engaging to most positively engaging. For caregivers: 1. negative affect and gaze away, 2. neutral affect and gaze away, 3. neutral affect and gaze toward infant, and 4. positive affect and gaze toward infant; for infants: 1. distressed affect and gaze away, 2. neutral affect and gaze away, 3. neutral affect and gaze toward caregiver's face or other body part, and 4. positive affect and gaze toward caregiver's face or other body part. Thus behaviours plotted in the upper right quadrant are most positively engaging, whereas those in the lower left quadrant are most negatively engaging.

protocol, and supports the behavioural patterns displayed by the state space grids in Figure 1, namely, that disengaging infant and caregiver behaviours increased significantly during the divided attention phase, and engaging infant and caregiver behaviours decreased significantly during the same phase, analogous to the original FFSF paradigm.

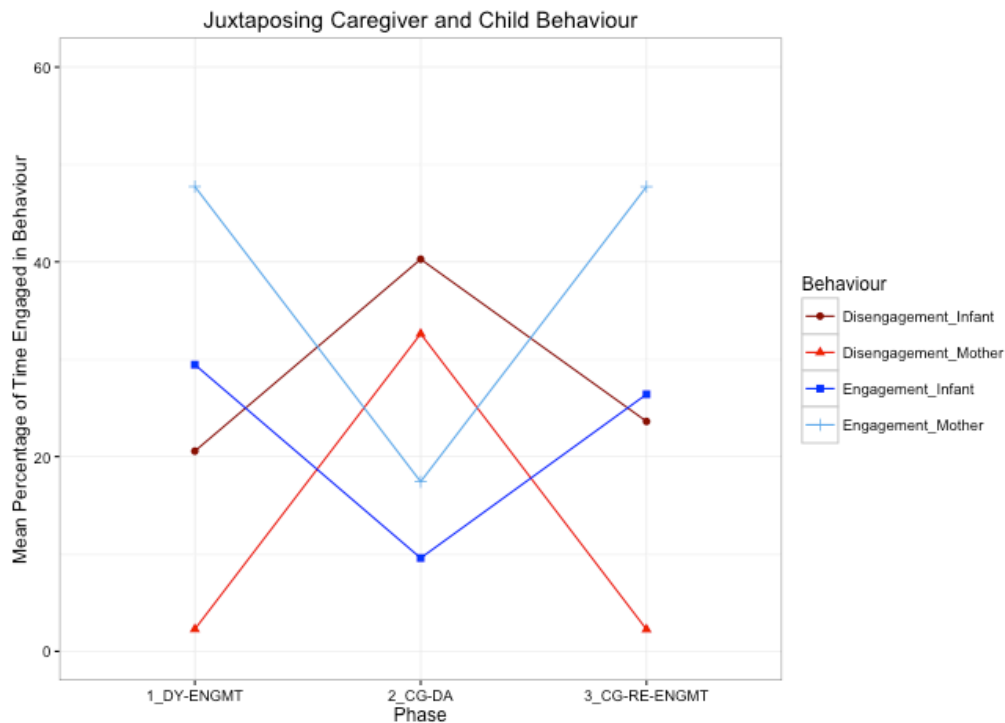


Figure 2. Caregiver and infant engagement and disengagement juxtaposed across the three phases (dyadic engagement = DY-ENGMT; caregiver disengagement [divided attention] = CG-DA; caregiver re-engagement = CG-RE-ENGMT) of the *cell phone engagement protocol*.

Hypothesis 1A: Caregivers' disengagement behaviours. A pairwise t test was conducted to evaluate the differences in caregiver disengagement behaviours (mean of the proportions of negative affect and gaze away/1 and neutral affect and gaze away/2) between the dyadic engagement (DY-ENGMT) and caregiver divided attention (CG-DA) phases, and the CG-DA and caregiver re-engagement (CG-RE-ENGMT) phases, respectively. There was a statistically significant increase in the percentage of disengagement behaviours from the DY-

ENGMT phase ($M = 2.27$, $SD = 5.49$) to the CG-DA phase ($M = 32.61$, $SD = 11.59$), $p < .001$. In contrast, there was a statistically significant decrease in the phase percentage of disengagement behaviours from the CG-DA phase ($M = 32.61$, $SD = 11.59$) to the CG-RE-ENGMT phase ($M = 2.25$, $SD = 3.32$), $p < .001$. No significant difference was found in the phase percentage of disengagement behaviours between the DY-ENGMT phase and the CG-RE-ENGMT phase ($p = .99$) (see Table 3).

This pattern of a significant increase in caregivers' disengagement behaviours from the dyadic engagement phase to the caregiver divided attention phase, followed by a significant decrease in disengagement behaviours from the caregiver divided attention phase to the caregiver re-engagement phase (Figure 3), suggests a behavioural pattern in the *cell phone engagement protocol* that is analogous to that of the original FFSF experiments.

Table 3

Comparing Percentage of Caregivers' Disengagement Behaviours by Phase

| Paired Phases | DY-ENGMT | | CG-DA | | CG-RE-ENGMNT | | Sig. |
|--------------------------|----------|-----------|----------|-----------|--------------|-----------|--------|
| | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> | |
| DY-ENGMT/CG-DA | 2.27 | 5.49 | 32.61 | 11.59 | | | < .001 |
| CG-DA/CG-RE-ENGMT | | | 32.61 | 11.59 | 2.25 | 3.32 | < .001 |
| DY-ENGMT/ CG-RE-ENGMT | 2.27 | 5.49 | | | 2.25 | 3.32 | .99 |

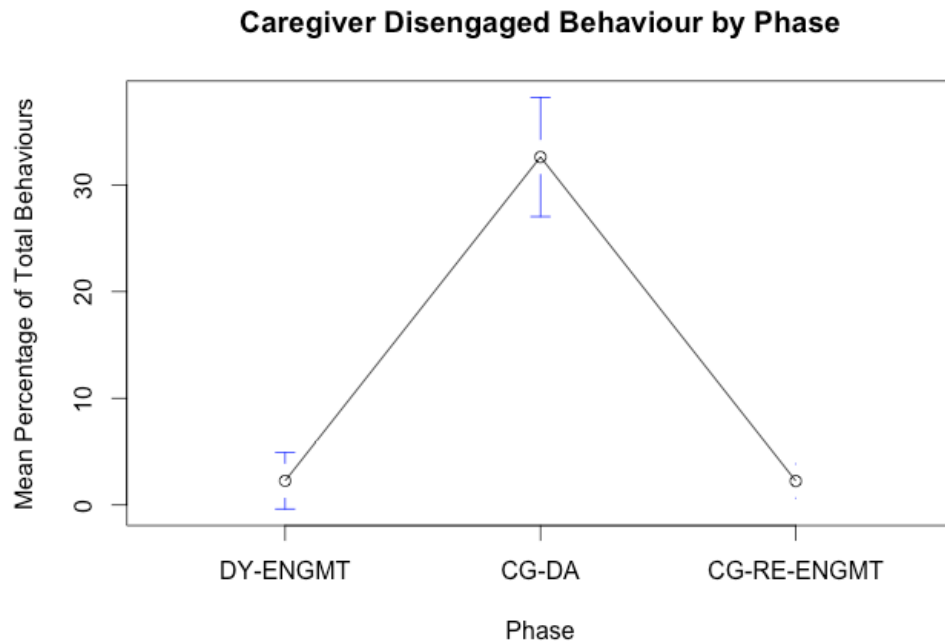


Figure 3. Caregivers' disengaging behaviours across the three phases of the *cell phone engagement protocol*.

Hypothesis 1B (i): Infants' disengagement and distress behaviours. A pairwise t test was conducted to evaluate the differences in infant disengagement behaviours (mean of the proportions of distressed affect and gaze away/1 and neutral affect and gaze away/2) between the DY-ENGMT and CG-DA phases, and the CG-DA and CG-RE-ENGMT phases, respectively. There was a statistically significant increase in the percentage of disengagement behaviours from the DY-ENGMT phase ($M = 20.56$, $SD = 15.05$) to the CG-DA phase ($M = 40.27$, $SD = 7.51$), $p < .001$. In contrast, there was a statistically significant decrease in the percentage of disengagement behaviours from the CG-DA phase ($M = 40.27$, $SD = 7.51$) to the CG-RE-ENGMT phase ($M = 23.61$, $SD = 14.72$), $p < .001$. No significant difference in the percentage of disengaging behaviours was noted between the DY-ENGMT and CG-RE-ENGMT phases ($p = .19$) (see Table 4). This pattern of a significant increase in infants' disengaging behaviour from the dyadic engagement to the caregiver divided attention phase, followed by a significant

decrease in these behaviours from the caregiver divided attention to the caregiver re-engagement phase (see Figure 4) also mirrors that of the original FFSF paradigm.

Table 4

Comparing Percentage of Infants' Disengagement Behaviours by Phase

| Paired Phases | DY-ENGMT | | CG-DA | | CG-RE-ENGMNT | | Sig. |
|---------------------------|----------|-----------|----------|-----------|--------------|-----------|--------|
| | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> | |
| DY-ENGMT/CG-DA | 20.56 | 15.05 | 40.27 | 7.51 | | | < .001 |
| CG-DA/CG-RE-ENGMNT | | | 40.27 | 7.51 | 23.61 | 14.72 | < .001 |
| DY-ENGMT/ CG-RE-ENGMNT | 20.56 | 15.05 | | | 23.61 | 14.72 | .19 |

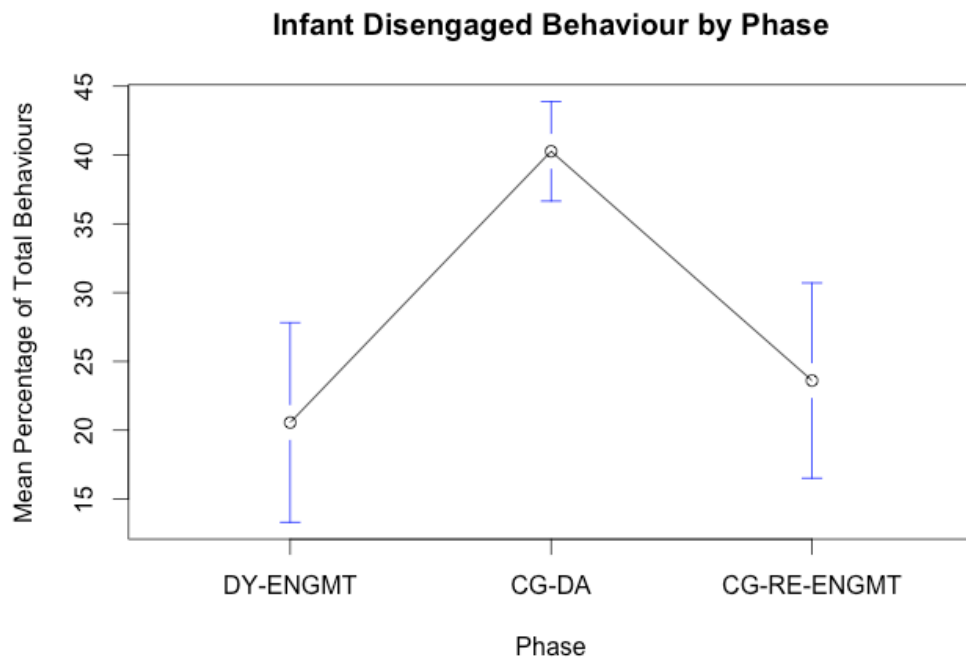


Figure 4. Infants' disengaging behaviours across the three phases of the *cell phone engagement protocol*.

Infants' distress reactions alone (*distressed affect and gaze away/1*) were also tallied and converted to a percentage for each phase of the experimental protocol. Phase was found to have a significant effect on infant distress behaviours, $F(1.91, 34.35) = 6.31, p < .05, \eta^2 = .16$. A pairwise t test showed a statistically significant increase in the percentage of infant distress behaviours from the DY-ENGMT phase ($M = 3.98, SD = 8.40$) to the CG-DA phase ($M = 14.51, SD = 13.90$), $p < .01$. There was a statistically significant decrease in the percentage of distress behaviours from the CG-DA phase ($M = 14.51, SD = 13.90$) to the CG-RE-ENGMT phase ($M = 6.76, SD = 8.85$), $p < .05$. However, there was no significant difference in the percentage of distress behaviours between the DY-ENGMT and CG-RE-ENGMT phases ($p = .38$) (see Table 5). These results are demonstrated visually in Figure 5.

Table 5

Comparing Percentage of Infants' Distress Behaviours by Phase

| Paired Phases | DY-ENGMT | | CG-DA | | CG-RE-ENGMT | | Sig. |
|--------------------------|----------|-----------|----------|-----------|-------------|-----------|-------|
| | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> | |
| DY-ENGMT/CG-DA | 3.98 | 8.40 | 14.51 | 13.90 | | | < .01 |
| CG-DA/CG-RE-ENGMT | | | 14.51 | 13.90 | 6.76 | 8.85 | < .05 |
| DY-ENGMT/ CG-RE-ENGMT | 3.98 | 8.40 | | | 6.76 | 8.85 | .38 |

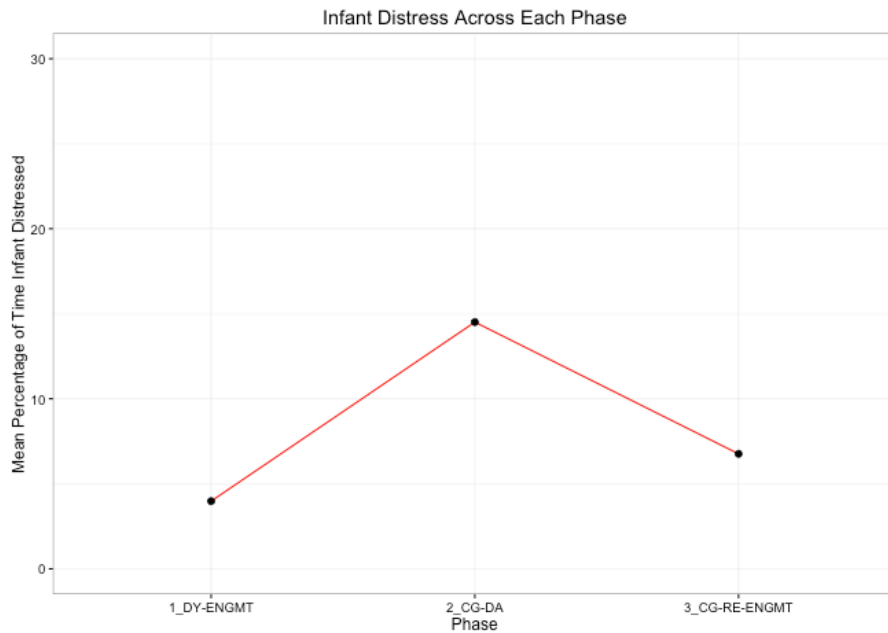


Figure 5. Infants' distress behaviours across the three phases of the *cell phone engagement protocol*.

Hypothesis 1B (ii). Infants' attempt to engage caregivers. Differences in infants' engaging behaviours (mean of the proportions of neutral affect and gaze toward caregiver's face or other body part/3 and positive affect and gaze toward caregiver's face or other body part/4) across the three phases were also evaluated using a pairwise t test. There was a statistically significant decrease in the percentage of engagement behaviours from the DY-ENGMT phase ($M = 29.44$, $SD = 15.04$) to the CG-DA phase ($M = 9.58$, $SD = 7.52$), $p < .001$. A statistically significant increase was found in the percentage of engagement behaviours from the CG-DA phase ($M = 9.58$, $SD = 7.52$) to the CG-RE-ENGMT phase ($M = 26.40$, $SD = 14.73$), $p < .001$. No significant difference in the percentage of engagement behaviours was found between the DY-ENGMT and CG-RE-ENGMT phases ($p = .19$) (see Table 6).

Table 6

Comparing Percentage of Infants' Engagement Behaviours by Phase

| Paired Phases | DY-ENGMT | | CG-DA | | CG-RE-ENGMNT | | Sig. |
|--------------------------|----------|-----------|----------|-----------|--------------|-----------|--------|
| | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> | |
| DY-ENGMT/CG-DA | 29.44 | 15.04 | 9.58 | 7.52 | | | < .001 |
| CG-DA/CG-RE-ENGMT | | | 9.58 | 7.52 | 26.40 | 14.73 | < .001 |
| DY-ENGMT/ CG-RE-ENGMT | 29.44 | 15.04 | | | 26.40 | 14.73 | .19 |

Although the graph depicting behaviours during the first minute of the caregiver re-engagement phase (Figure 1) shows statistically more significant negative infant behaviours than the graph depicting the second minute of the dyadic engagement phase (representing a lag in re-engagement by infants), this lag is not statistically significant when considering the entire two minutes of the dyadic engagement and caregiver re-engagement phases ($M_{DY-ENGMNT} - M_{CG-RE-ENGMT} = 29.44 - 26.40 = 3.04, p = .19$) (Figure 6). However, as discussed above, there are significant differences in the percentage of infants' engaging behaviours between phases [$F(1.70, 30.59) = 27.06, p < .001, \eta^2 = .33$].

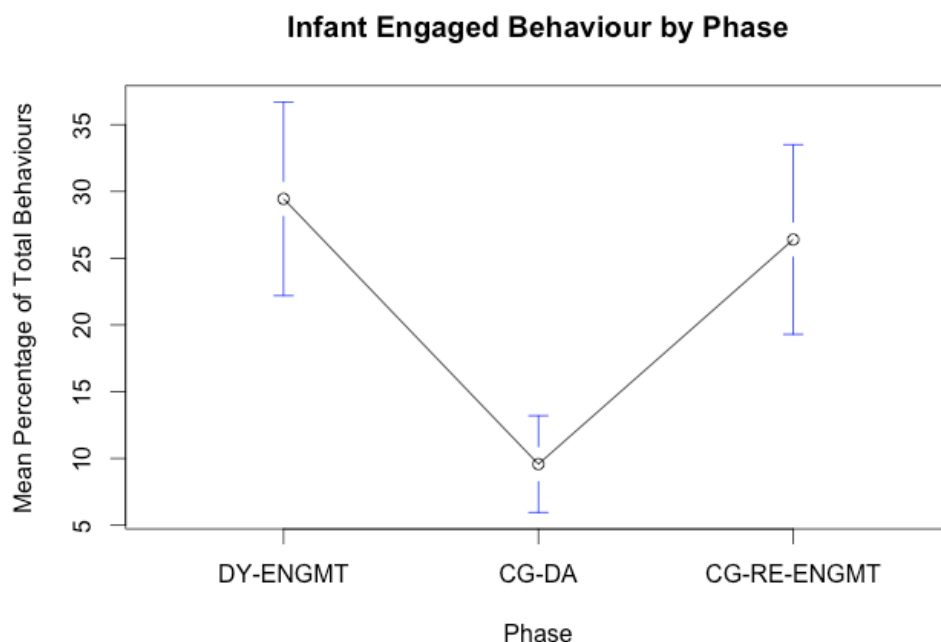


Figure 6. Infants’ attempts to engage caregivers (engaging behaviours) across the three phases of the *cell phone engagement protocol*.

Hypothesis 2: The frequency and severity of caregivers’ self-reported attention difficulties predicts their disengaging behaviours during the caregiver divided attention phase.

Caregivers’ self-ratings on each of the 18 questions of the ASRS-v1.1 were assigned the following values: “never” = 1, “rarely” = 2, “sometimes” = 3, “often” = 4, “very often” = 5. Marks made in the darkly shaded boxes next to each question suggested that the participant had symptoms highly consistent with ADHD. Only scores that appeared in these shaded boxes were summed, and a total score was assigned to each of the twelve caregivers who completed this measure. Higher scores on the ASRS represent more frequent and more severe attention difficulties.

Pearson product-moment correlations were conducted in RStudio to evaluate the relationship between caregivers’ total ASRS scores and the frequency of each of their behaviours

[categories 1, 2, 3, 4, disengagement (mean of 1+2), and engagement (mean of 3+4)], respectively, during the caregiver divided attention phase. A high but non-significant negative correlation was found between disengaging behaviours and ASRS scores, $t(10) = -1.77$, $p = .11$, $r = -0.49$ (see Figure 7). Interestingly, a high but non-significant negative correlation was also found between category 2 behaviours only (*neutral affect and gaze away/2*) and ASRS scores. Similarly, a high but non-significant positive correlation was found between engaging behaviours and ASRS scores, $t(10) = 1.74$, $p = .11$, $r = 0.48$ (see Figure 8). No other correlations were large or significant.

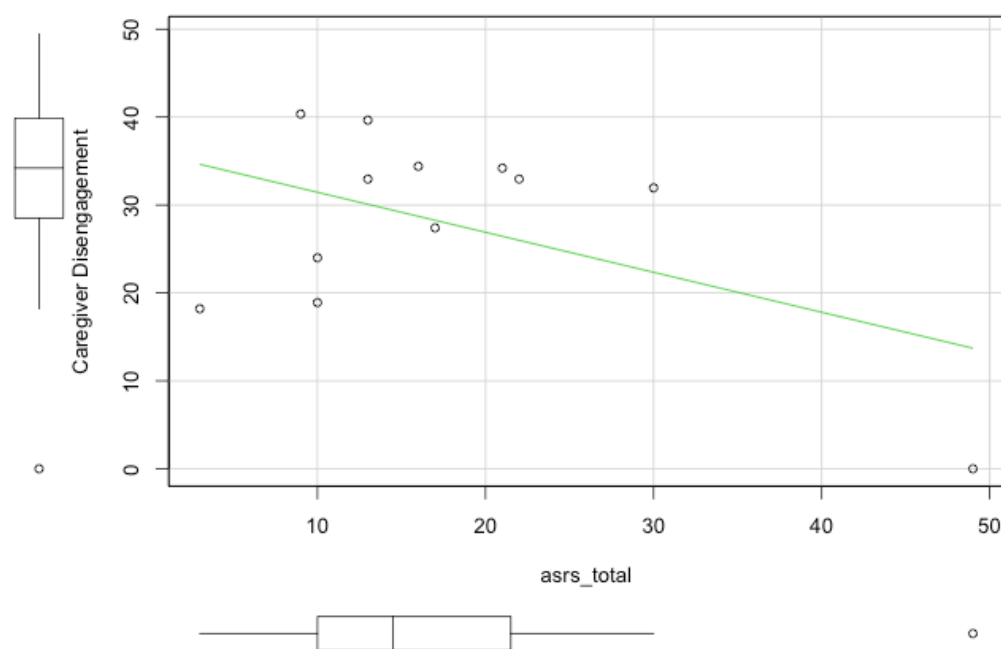


Figure 7. Correlation between the percentage of caregivers' disengaging behaviours (mean of *negative affect and gaze away/1* and *neutral affect and gaze away/2*), and their total ASRS scores during the caregiver disengagement phase of the *cell phone engagement protocol*.

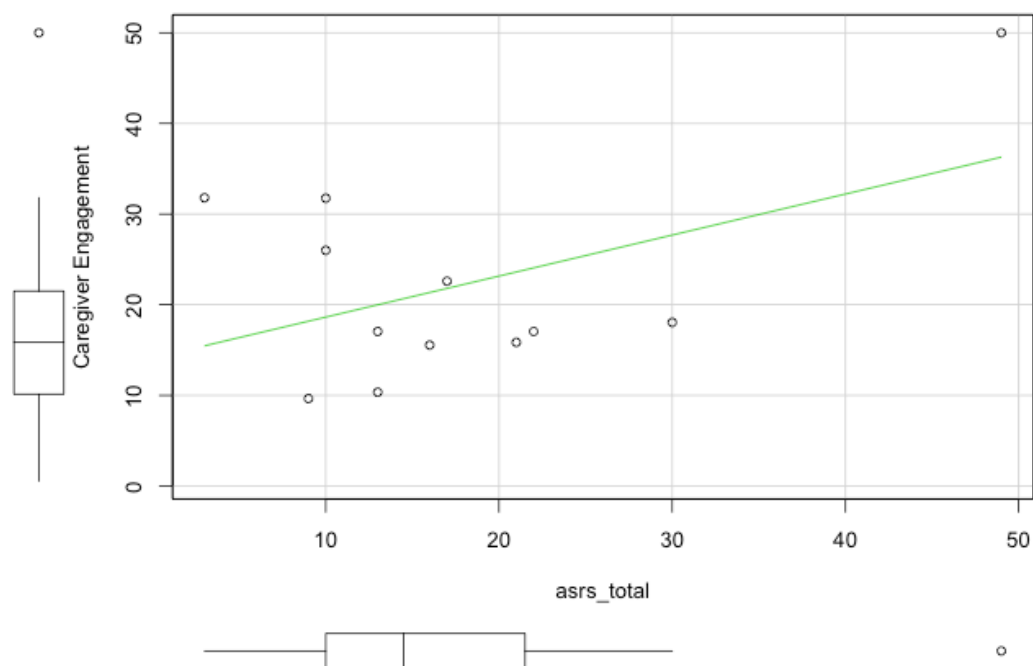


Figure 8. Correlation between the percentage of caregivers' engaging behaviours (mean of *neutral affect and gaze toward infant/3* and *positive affect and gaze toward infant/4*), and their total ASRS scores during the caregiver disengagement phase of the *cell phone engagement protocol*.

Hypothesis 3: Caregivers' performance on a divided attention task predicts the frequency of their engaging behaviours during the caregiver divided attention phase.

Caregivers' correct responses were summed for each part of the PASAT (PASAT-3" and PASAT-2", respectively), and also added to produce a total PASAT score for each of the twelve caregivers who completed this measure. Higher scores represented better divided attention abilities, and thus higher attentional capacity. Pearson product-moment correlations were conducted in RStudio to evaluate the relationship between caregivers' total PASAT scores with the percentage of each caregiver behaviour [categories 1, 2, 3, 4, disengagement (mean of 1+2), and engagement (mean of 3+4)] during the caregiver divided attention phase. No significant correlations were found. In addition, caregivers' PASAT-3" and PASAT-2" scores were also

correlated with each of those behaviours, respectively, and no significant correlations were found. However, after removing one outlier from the PASAT scores, a high but non-significant correlation was found between PASAT-3” scores and the most negative caregiver behaviour (negative affect and gaze away/1) during the caregiver divided attention phase, $t(9) = 2.03$, $p = .07$, $r = .56$ (Figure 9).

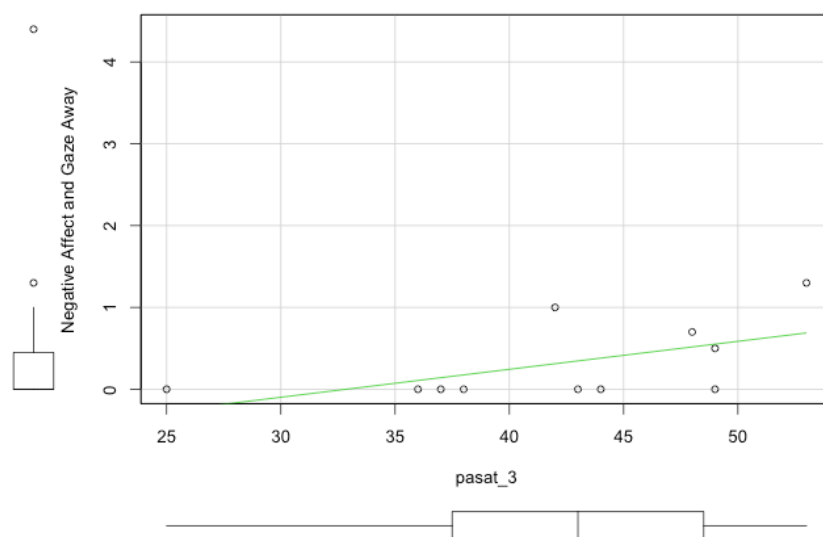


Figure 9. Correlation between the percentage of caregivers’ most disengaging behaviour (*negative affect and gaze away/1*) during the caregiver disengagement phase of the *cell phone engagement protocol*, represented by “*distress1*” on the y-axis, and their PASAT-3” score.

Hypothesis 4: Caregivers’ MTUAS scores predict their intensity of disengagement when engaged with a mobile device (caregiver divided attention phase).

To determine caregivers’ reported level of technology use and their attitudes toward technology, three scores were obtained from the MTUAS questionnaire: the usage subscale score, the attitude subscale score, and the total MTUAS score (combination of the usage and attitude subscale scores). Caregivers’ intensity of disengagement was represented by each of

their four behavioural categories, their disengaging behaviours (average of the percentages of category 1 and 2 behaviours), and their engaging behaviours (average of the percentages of category 3 and 4 behaviours).

Pearson product-moment correlations were conducted to determine the relationships between each of these caregiver behaviours and each of the three MTUAS scores, respectively. No significant correlations were found between any of these variables. However, after removing three outliers from the MTUAS scores, a significant negative correlation was found between caregivers' most engaging behaviour (*positive affect and gaze toward infant/4*) and their technology *usage* scores (Figure 10), $t(14) = -2.61, p = .02, r = -0.57$. Thus, the higher caregivers' reported technology usage, the less positive affect they displayed and the less they gazed toward their infant during the caregiver divided attention phase. Similarly, a significant negative correlation was also found between caregivers' most engaging behaviour (category 4) and caregivers' *total* MTUAS scores (Figure 11), $t(14) = -2.26, p = .04, r = -0.52$. Therefore, 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. No significant correlation was found between this behaviour and the attitude subscale scores. Similarly, no significant correlations were found between caregiver disengaging behaviours (mean of the percentages of category 1 and 2 behaviours) or caregiver engaging behaviours (mean of the percentages of category 3 and 4 behaviours) with each of the three MTUAS subscales, respectively.

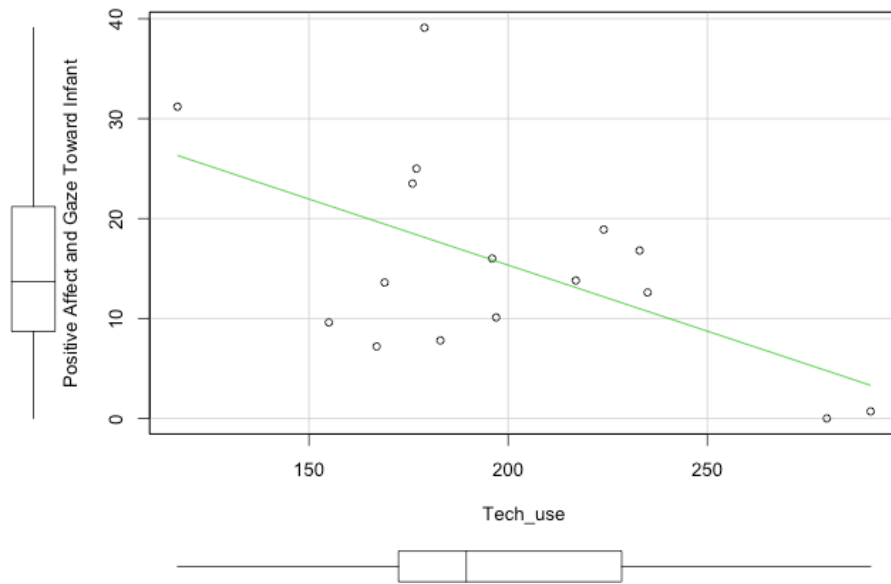


Figure 10. Correlation between the percentage of caregivers' most engaging behaviour (*positive affect and gaze toward infant/4*) during the caregiver disengagement phase of the *cell phone engagement protocol* and their technology usage scores.

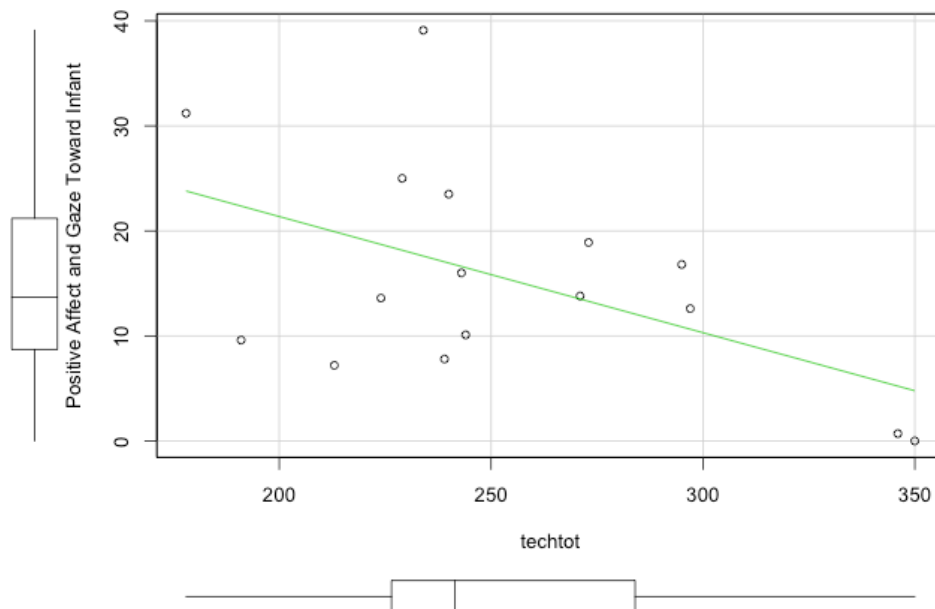


Figure 11. Correlation between the percentage of caregivers' most engaging behaviour (*positive affect and gaze toward infant/4*) during the caregiver disengagement phase of the *cell phone engagement protocol* and their total MTUAS scores.

Discussion

The potential impact on parent-child relationships of caregivers' pervasive, intense engagement with mobile technology is a topic that merits attention. Indeed, extant literature suggests that engagement with technology may adversely affect not only romantic relationships and parent-adolescent relationships, but also dyadic relationships between caregivers and very young children, by dividing caregivers' attention and impairing sensitivity (Ainsworth, 1979; Wei & Lo, 2006). In the current study, we predicted that the behavioural patterns displayed by caregiver-infant dyads in a divided attention context, where caregivers were intensely engaged with their mobile phone, would resemble the conditions created in the classic Still-Face experiments (FFSF; Tronick et al., 1978). Specifically, we hypothesized that caregivers' sensitivity would be impaired as they disengaged from their infants during the *cell phone engagement protocol*, similarly to the disengagement behaviours recorded in the FFSF paradigm. We also predicted that infants' reactions to caregiver disengagement, and the difference in frequency of attempts to engage caregivers, would be similar to the behaviours observed in the FFSF studies, when caregivers were asked to assume an unresponsive expression in the presence of their child for a period of time. Moreover, we hypothesized that a relationship would exist between caregivers' behaviours during the caregiver divided attention phase, and: 1) the frequency and severity of their self-reported attention difficulties; 2) caregivers' performance on a divided attention task and 3) their reported technology use, or attitude toward technology, or a combination of both.

Findings confirmed our first hypothesis, were opposite to those predicted by Hypotheses 2 and 3, and partly confirmed our final hypothesis. Overall, notable similarities were found between caregivers' behaviours when absorbed in mobile phone activity and those in the original

FFSF paradigm studies. Caregivers' disengagement behaviours increased significantly during the divided attention phase, suggesting that mothers' intent focus on answering questions with their mobile devices promoted disengagement from their infants, and thus made them less responsive, similarly to the still-face condition in the original FFSF paradigm. Furthermore, this study's *cell phone engagement protocol* provoked infant reactions that were comparable to the infant behaviours triggered by the still face episode in the original FFSF experiments. Specifically, a significant increase was noted in the percentage of infants' disengagement behaviours when in the presence of a caregiver who was engrossed with a cell phone, with infants seemingly experiencing distress similar to that recorded in the FFSF experiments (Field et al., 1986; Oppenheimer et al., 2013). Infants' distress behaviours alone (Figure 5) were also prevalent in the caregiver divided attention phase. We therefore posit that infants experience some distress when their caregivers withdraw after dyadic engagement in order to shift their attention to a mobile device.

Infants' attempts to engage caregivers differed in frequency across the three phases, as in the pattern seen in the original FFSF paradigm: when mothers disengaged from the dyadic interaction, infants showed significantly fewer engaging behaviours, but increased their engagement when mothers resumed a typical interaction. However, the lag in re-engagement recorded in the original FFSF experiments was not found in our study, with infants showing a similar percentage of engaging behaviours during both dyadic engagement and caregiver re-engagement. This difference in findings may be a result of the combining of two infant behavioural categories into "infant engagement". When examining *neutral affect and gaze toward caregiver's face or other body part/3* alone, there was a surprising increase in these behaviours from dyadic engagement to caregiver re-engagement, while analysis of *positive affect*

and gaze toward caregiver's face or other body part/4 alone, reveals the expected larger decrease in these behaviours from dyadic engagement to caregiver re-engagement than what is observed with the combined engaging behaviours. Because the only difference between category 4 behaviours and combined engagement behaviours is affect, it is possible that neutral affect does not appropriately define “engagement”, and may more likely be part of the *disengaging* category in our coding scheme (*neutral affect and gaze away/2*). Thus, “true” engagement consisting solely of category 4 behaviours indeed shows a lag in re-engagement by infants similar to that in the original FFSF paradigm. Future studies, in addition to recruiting more participants, should address this issue by better distinguishing between the behavioural categories that define “engaging” behaviours and “disengaging” behaviours in caregivers and infants.

According to the second hypothesis, the greater the frequency and severity of caregivers' self-reported attention difficulties, the less sensitively they might behave with their infants while absorbed with their mobile device, i.e. displaying more disengaging behaviours such as negative or neutral affect and gazing away from their infant. Surprisingly, the current results showed the opposite to be true: the more attention difficulties that caregivers reported, the *fewer* disengaging behaviours they exhibited, and the *more* engaging and sensitive they were toward their infants. Perhaps the participating caregivers found it more challenging to focus their attention on their mobile phones, as they were consistently receiving cognitively-demanding questions through text messages from the researcher during the caregiver divided attention phase. Consequently, these mothers may have felt compelled to divert their attention away from their phones more frequently, in order to respond to their infant's demands through gaze and positive facial expressions. Additionally, mothers who are used to struggling with attention difficulties may

have learned to develop effective compensatory strategies, thus being able to attend to multiple stimuli even if only for a short period of time.

The third objective of this study was to determine the relationship between mothers' performance on a divided attention task and their level of maternal sensitivity during the caregiver divided attention phase of the protocol. As with the first neuropsychological measure of attentional capacity, results were not in line with the proposed hypothesis: indeed, the *better* caregivers' ability to divide their attention, the *more* negative affect they showed, and the more they gazed away from their infants. This finding may be explained by growing research evidence that suggests that the concept of "multi-tasking" may be a myth (e.g., Wang & Tchernev, 2012; Bowman, Levine, Waite, & Gendron, 2010; Ophir, Nass, & Wagner, 2009). Indeed, media multitasking has "adverse impacts on task performance and learning" (Wang & Tchernev, 2012, p. 493-494). It is possible that mothers who frequently multi-task and believe they can master several tasks simultaneously, scored high on the measure as they were intently focused on the task at hand while in an experimental situation. However, in the more naturalistic setting of interacting with their infant while in their own home, these mothers may have reverted to their "normal" state of multi-tasking, in which the habitual draw of the mobile device content was greater than their perceived demands of the infant. Consequently, their multi-tasking may not have been as effective as in the experimental situation, and resulted in less sensitivity toward their child. In contrast, mothers who do not experience themselves as being able to multi-task are likely less confident in both the experimental and naturalistic conditions, and make more attempts at engaging with their infant during the caregiver divided attention ("multi-tasking") phase. Another possibility is that mothers who are good at the experimental "multi-tasking" task may be more goal oriented, better at instrumental tasks, more technologically savvy, and better at

controlling their environment. None of these traits are necessarily conducive to maternal sensitivity and responsiveness, which is important for responding to the sometimes unpredictable demands of the child and linked to the development of secure attachment. Thus, these moms may be more “avoidant” rather than “secure” with their infants. Both of these explanations may be worthy of closer examination in future studies.

The final objective of the current study was to examine the relationship between caregivers’ attitudes toward technology and their reported technology use, and the sensitivity of their behaviours during the caregiver divided attention phase of the protocol, respectively. When discounting clear outliers, a significant negative correlation can be identified between caregivers’ positive attention directed to their infant and their technology use scores, suggesting that caregivers who use technology more frequently (on any device and in various ways), are prone to show less positive emotions to their infants and look at them less frequently when absorbed with their mobile phones. This finding is concerning as parents who use technology more frequently might show less sensitivity toward their infants in daily dyadic interactions. The implications are particularly worrisome in the modern digital era where 91% of parents own a mobile phone and two-thirds are part of social network websites (Lenhart et al., 2011). Similarly, a significant negative correlation was identified between caregivers’ most positive behaviours and their total MTUAS scores, but there was no significant correlation with caregivers’ *attitudes* toward technology. Intuitively, actual daily technology usage patterns (especially use of smartphones) would have a larger effect on the way parents behaved when asked to engage with mobile technology, as compared to their cognitions about it. Perhaps caregivers who have positive attitudes toward technology are able to delineate in which contexts it is appropriate to manifest that attitude, and evaluated that it was important to continue engaging with their infants while

partaking in a divided attention task involving technology. Furthermore, the items in the attitudes subscale were not specific to attitudes about mobile devices. These explanations may account for the significant correlations with technology *use* and *total* MTUAS scores, but not with *attitudes* toward technology alone.

The lack of a significant correlation found between each of the MTUAS scales and the rest of the caregiver behaviours may be explained by the fact that the items within the technology use and attitudes toward technology scales were not specific to smartphones, and included items pertaining to other technological devices (TV, computer, etc.), Internet use in general, and video games. In addition, after the removal of outliers, the sample size of caregivers was small. Future studies should include a larger sample size and explore correlations with items that are more specific to mobile technology.

A significant limitation of the current exploratory investigation was the small sample size, especially as pertained to the neuropsychological measures. Larger scale studies are needed to replicate these findings with more participants, and with a greater diversity of caregiver-infant dyads. The validity of the current findings could also be enhanced through the coding of more specific behavioural categories for caregivers and infants and more advanced video equipment to better capture the dyad's gaze and affective expressions. Future studies could also incorporate physiological measures of caregiver and infant stress throughout the three dyadic phases of the interaction of interest. Additional considerations could include examining the impact of other variables, such as: caregiver's gender (Braungart-Rieker et al., 1998), child's age (Adamson & Frick, 2003; Melinder et al., 2010; Weinberg et al., 2008), the cultural background of caregiver-infant dyads (Kisilevsky et al., 1998; Liu et al., 2013), and an ADHD diagnosis in caregivers (Murray & Johnston, 2006).

If this study can be replicated, the results would have significant implications for young caregivers and their children in an era where mobile technologies are increasingly prevalent in daily living contexts (Conradt & Ablow, 2010; Haley & Stansbury, 2003; Ham & Tronick, 2006). Given the continued rise of communication technology use worldwide, it is also important to study the long-term effects of mobile technology use on caregiver-child relationships through longitudinal developmental studies.

Conclusion

Currently, to our knowledge, there are no social policies or agencies that directly address the issue of excessive mobile technology usage by caregivers in the presence of their infants. Yet, if the findings of the present study can be replicated, *and* if it is established that caregiver “disengagement” results in potentially negative short-term and long-term effects for infants, disengagement that happens when a caregiver is focused on their phone may result in an at best suboptimal, at worst hazardous chronic developmental environment. As demonstrated in this study, the decreased engagement of caregivers, in a context in which their attention is divided between an infant and a highly compelling electronic device, is worrisome, as caregiver sensitivity to infant cues and distress uniquely predicts child attachment security, physiological and behavioural regulation, and social competence (Contradt & Ablow, 2010). These concerns are exacerbated by the reality that mobile communication technology is ubiquitous, and the frequency and duration of its use on a rapid rise (e.g., Pew Research Centre, 2017). It would be desirable if this and future studies could trigger a widespread discussion about the potential implications for caregiver sensitivity of the division of attention created by parents’ intense engagement with digital technology in the presence of their young children. Such a discussion could facilitate the development of guidelines on appropriate mobile technology use for new parents who are interested in promoting their infant’s optimal development.

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Appendix A

Text Messages Sent to Caregivers

We will now begin to send you questions in the format of text messaging. When choices are given, simply indicate the corresponding letter of choice. If there is a question you require clarification, type “QUESTION” and we will provide you with the next question. Please send us a text if there is anything you would like to communicate with us and you may now proceed to answer the questionnaire.

1. List 5 words that you would use to describe your child.
2. How many text messages did you receive from your friends or family since the start of this experiment?
3. Complete the statement: I use my phone mostly to _____.
4. When do you usually reply to a text message after you receive it?
 - a) Immediately
 - b) Within 5 minutes
 - c) Within an hour
 - d) Within several hours
 - e) After a day or more
5. What is your level of comfort right now?
 - a) Very Comfortable
 - b) Comfortable
 - c) Somewhat Comfortable
 - d) Uncomfortable
 - e) Extremely Uncomfortable
6. How much time do you usually spend on interacting with your child alone everyday?
 - a) less than 1 hour
 - b) 1-3 hours
 - c) 3-6 hours
 - d) more than 6 hours