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Parent-child interactions during joint engagement with touchscreen technology: A comparison of younger versus older toddlers

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Abstract

With a plethora of touchscreen apps aimed at young children, parents are receiving mixed messages about the appropriateness of such technology for their toddlers. The American Academy of Pediatrics (2016) advises limited engagement with digital media for this age group and encourages parents to co-engage with children when they are using screens. However, very little is known about parent-child interaction in the context of joint engagement with digital screen media in the toddler years. This study observed 56 toddlers (*M* = 32.5 months old; 53 % female) and a parent (52 mothers; 4 fathers) performing a 3-minute drawing task on a touchscreen tablet (digital condition), and on an Etch-A-Sketch (non-digital condition) using a repeated measures design. Observations were analysed using global ratings of dyadic interaction, comparing warmth, cooperation and conflict between digital and non-digital conditions. A mixed MANCOVA analysis, controlling for levels of daily usage of touchscreens, revealed lower levels of parent-child cooperation and warmth in the digital condition compared to the non-digital condition. In addition, there was a main effect of age with younger dyads displaying less cooperation overall, particularly in the digital condition where interactions were also less warm. Results suggest that co-engaging with digital technology can be a challenging and potentially emotionally charged context for both parents and young children. Younger toddlers, especially, may be more likely to experience less cooperative interactions when co-engaging with digital technology with a parent. Results are discussed in relation to developmental differences between 2- and 3-year olds, and the need for more nuanced guidance for parents supporting young children's interaction with digital media.

Keywords: Toddlers, touchscreen technology, parent-child interaction, cooperation, warmth

Parent-child interactions during joint engagement with touchscreen technology: A comparison of younger versus older toddlers

Young children are increasingly frequent users of mobile and digital technologies including touchscreen tablets and smartphones (Lauricella, Wartella, & Rideout, 2015). The home has become a rich technological landscape in which multiple device ownership is now more likely than not (Cieciura, Mason, Coleman, & Paradis, 2019), and children are gaining access to their own devices at increasingly younger ages. Nationally representative survey data show that in the UK 24% of 3- and 4-years olds own their own tablet (Ofcom, 2020), and in the USA tablet ownership increases from 5% in the under 2s to 43% of 2- to 4-year olds (Rideout, 2017). It is clear from this data that the use of mobile technologies has very quickly become ubiquitous in the home and forms a significant part of very young children's daily experience. However, research has lagged behind these rapid rates of adoption (Radesky, Schumacher, & Zuckerman, 2015) and our understanding of how digital environments impact on developmental processes, particularly for children under 3 years old, is still very limited. As such, the American Academy of Pediatrics (2016) advises parents to limit toddlers' use of digital screen media and encourages parents to 'co-engage' with children when they are using screens. Similarly, the British Psychological Society advises parents to 'co-use' digital media in order to help young people gain the most from their experience (Galpin & Taylor, 2018).

These guidelines are rooted in developmental research and theory emphasizing the central role of parent-child interaction in social-emotional and cognitive development (Belsky, Taylor, & Rovine, 1984; Dunn, 1993; Kochanksa, 1997; Maccoby, 1992). Parental interactions high in warmth and dyadic mutuality play a vital role in supporting the child's developing understanding of the self as well as their social and physical worlds (Deater-Deckard, 2000; Kochanska & Aksan, 2004). From a socio-cultural perspective, parental support and assistance during joint activity scaffolds children's skills and understanding as

they reach higher levels of thinking within the zone of proximal development (Vygotsky, 1978). Co-engaging in the context of digital media use involves sharing media experiences and activities such as playing, reading, creating or viewing content together in a manner which requires interaction and shared meaning making (Ewin, Reupert, McLean, & Ewin, 2020). It is related to the practice of 'social co-viewing' in which the presence of a co-viewing adult offering comments and discussion has been shown to reduce some of the potentially more negative effects of passive television consumption (Valkenburg, Krcmar, Peeters, & Marseille, 1999). Co-engagement with parents provides opportunities for children's active interaction with digital media in the context of warm close relationships.

However, early evidence suggests that very young children's use of digital media is often individual in nature rather than part of joint parent-child activity (Livingstone, Marsh, Plowman, Ottovordemgentschenfelde, & Fletcher-Watson, 2014). In particular, parents report often using digital media to occupy children while they are busy and engaged in other activities, and therefore digital engagement tends to fill a gap for parents rather than becoming a focal point of parent-child interaction (Chaudron, 2015). There is also evidence that parents are less likely to co-engage with their children when using digital technologies compared to more traditional technologies such as books and television (Connell, Lauricella, & Wartella, 2015), with the likelihood of co-use mediated by parental education, age and gender (Levine, Waite, Bowman, & Kachinsky, 2019). We do know that parents play a critical role as gatekeepers of young children's digital engagement (Dias et al., 2016) and as key agents of socialization where parental attitudes, behaviours and consumption of screen media are closely aligned with children's own patterns of media use (Levine et al., 2019; Wartella, Rideout, Lauricella, & Connell, 2014). However, very little is known about the mechanisms and dynamics of parent-child interaction when engaged in digital versus traditional activity with very young children.

While parents may not report high levels of shared digital media use at home, experimental studies have demonstrated parents are highly engaged with their children when observed during shared digital interactions and provide a range of scaffolding interventions to support learning (Wood et al., 2016). Neumann (2018) found that parents of 2- to 4-year olds most frequently provided cognitive scaffolding interventions during shared use of an early literacy app and provided more technical scaffolding to younger children as they navigated both the technology and the task. Zack and Barr (2016) found that parent-child interactions high in emotional responsiveness, maternal structuring and diverse verbal input, supported infants in a transfer of learning task using touchscreen tablets. While these studies are important in demonstrating the type of support parents provide during shared digital activity, they do not directly compare interactions in digital and non-digital environments. It is therefore plausible that observations reflect the nature of individual dyads and the quality of the parent-child relationship in general, rather than the context of shared digital media use in particular.

While studies addressing this question are limited, there is evidence from the literature on shared book reading that the nature and quality of interactions differ between digital and non-digital contexts. These studies typically find no differences between platforms in children's comprehension (Lauricella, Barr, & Calvert, 2014) or recall (Yuill & Martin, 2016) of stories, but importantly do find differences in levels of parental engagement (Lauricella et al., 2014), warmth (Yuill & Martin, 2016), and child enjoyment (Strouse & Ganea, 2017a) in favour of print over electronic books. In contrast to studies of older children, Strouse and Ganea (2017b) also found that infants and toddlers showed more engagement and attention for electronic book reading with a parent than print book reading. While these findings are mixed, they do suggest differences in the nature and quality of parent-child interaction in digital and non-digital contexts. In particular, young children may be more engaged and interested in the digital experience related to the

additional features provided and the novelty of electronic books, but the quality of parent-child interaction may be poorer in these conditions. While this may partially be due to the affordances of electronic devices over print books (Yuill & Martin, 2016), shared reading also represents a particular sociocultural context in which parental attitudes and behaviours are framed against educational practices where traditional book reading is central to children's literary development. The quality of parent-child interactions and engagement with wider digital material, not necessarily underpinned by learning priorities, is still not well understood. Furthermore, it is important to address a wider variety of tasks which do not necessarily present the same multi-modal experience as shared book reading, in order to examine differences between digital and non-digital environments. In the current study we compare interactions during a structured cooperative drawing task (Etch-a-Sketch) in both digital and non-digital conditions to identify if and how shared digital activity represents a unique context for parent-child interactions. The task features are the same in both conditions and thus allow us to make a more direct comparison between digital versus non-digital.

In the current study we observed parent-child interactions during a structured cooperative task in a digital condition using a touchscreen tablet, and compared dyads performing the same task in a non-digital condition using a physical toy. We predicted interactions in the digital condition would be less cooperative and warm than interactions in the non-digital condition based on previous literature from electronic book reading. We also note important age-related differences in previous work where younger children were more engaged and showed better attention for digital tasks than older children (Strouse & Ganea, 2017b). These studies have tended to compare older pre-school or school-aged children with infants and toddlers, and little is known about differences within the first 3 years. Touch is a primary modality through which very young child interact with and explore the world around them (Smith & Gasser, 2005). Thus, touchscreen technology potentially offers

toddlers an engaging and intuitive means of interacting with digital content. Indeed, we see that children as young as 12 months are able to tap, flick and press with a degree of mastery concordant with their sensorimotor development (Cristia & Seidl, 2015). However, it is not until 2 years of age that intention and the full range of skills needed to interact purposefully with touchscreens are acquired (Ahearne, Dilworth, Rollings, Livingstone, & Murray, 2016). These relate to both motor development and control, such as intentionally dragging objects across the screen, as well as developments in executive functions, such as self-regulation and intentional action (Russo-Johnson, Troseth, Duncan, & Mesghina, 2017).

Differences in fine motor, language and cognitive development within the toddler years are therefore likely to impact parent-child interactions. In the current study we compare parent-child interaction with older and younger toddlers in order to gain a more nuanced understanding of shared digital media use within the toddler years.

Method

Participants

Recruitment took place in and around a small city in the South-East of England, where flyers were handed out at local nurseries and childcare settings, and an advert was posted on toddler- related community groups on social media. Parents were given a £10 gift voucher for taking part and children a set of crayons, a colouring book, and a sheet of stickers.

56 parent-child dyads (n = 26 boys; n = 30 girls) took part in the study. The children's ages ranged from 24 to 45 months, M = 32.5 months (SD = 5.8) with parents reporting their ethnicity as: British Asian (n = 1); White British (n = 47); White other (n = 7) and one who declined to provide information on ethnicity. Parents' ages ranged from 28 to 46 with a mean age of 35 (SD = 4.5). Most of the parents in the sample (n = 39) were educated to at least a degree level, with 42.8 % (n = 24) stating that they had a postgraduate qualification.

Parents were asked to rate their child's use of mobile touchscreeen technologies by reporting how many hours in a typical day children spent using tablets, smartphones, or other digital touchscreen devices. Daily usage ranged from never (*n* = 16), up to one hour a day (*n* = 28), up to two hours a day (*n* = 6), between two to four hours a day (*n* = 1), and more than four hours (*n* = 1). This data was missing for four of the children.

The majority of children (*n* = 47) were accompanied by just their mother. Of the rest, four were accompanied by just their father, two by both their mother and father, and three by their mother and a grandparent. The interaction task required one adult to perform the task with the child; 52 children did this with their mother and four with their father.

Design

A repeated measures design was used in which all parent-child dyads took part in an observational drawing task in both a digital and a non-digital condition. The order of conditions was counterbalanced with half the dyads (*n* = 28) performing the digital task first and half (*n* = 28) performing the non-digital task first.

Measures

Online questionnaire

Parents were asked to complete an online questionnaire before bringing their children in for the session. This contained demographic questions about the parent who would be accompanying the child (date of birth; gender; nationality; ethnicity; employment status; occupation; highest level of education; marital status; and [if relevant] partner's highest level of education, employment status, and occupation) and demographic information about the child (date of birth; gender; number, age, and gender of siblings; and approximate amount of the time the child spends per day interacting with a digital touchscreen/device).

The tower building task

Children were asked to build a tower from a set of smooth wooden blocks as a measure of fine motor ability. The children were asked to build the tallest tower they could and the greatest number of blocks they managed to stack one on top of the other before it fell over was taken as their score for this task. The number of blocks children stacked ranged from 2 to 12 (with an additional 3 children who did not want to do the task and therefore got a score of zero), with a mean of 6.8 blocks (*SD* = 3.1). The number of blocks children managed to stack on top of one another significantly correlated with the child's age (in months), $r = 0.37$, $p = 0.005$.

Ages and stages questionnaire: communication

Parents completed the communication subscale of the Ages and Stages Questionnaire (ASQ; Squires et al., 2009). This consisted of six questions assessing age-adjusted communication abilities, e.g., 'If you point to a picture of a ball and ask your child, "What is this?" does your child correctly name the picture?' (24 months). Answers are scored according to responses on a 3-point scale of 'not yet' (0), 'sometimes' (5), and 'always' (10). The range of possible scores is 0–60 and children are considered to be either 'on schedule', 'close to the cut-off', or 'below the cut-off'. In the current sample, *n* = 50 were on schedule, *n* = 3 were close to the cut-off, and *n* = 3 were below the cut-off. Raw scores have been used to indicate communication ability in the current sample.

The Parent-Child Interaction System (ParChiSy; Deater-Deckard et al., 1997)

The Parent-Child Interaction System (ParChiSy; Deater-Deckard et al., 1997) was used to code the video-recorded interaction task for both the digital and non-digital conditions. The ParChiSy measures individual and dyadic behaviour using global rating scales in which interactions are coded using a 7-point rating scale on a number of behavioural dimensions. A total of 14 behaviours were coded in the current study: parent

positive content (1 = no positive content; 7 = extensive use of explanation, questioning, and praise); parent negative content (1 = no negative content shown; 7 = exclusive use of criticism and physical control of dials and/or child's hand/arm/body); parent positive affect (1 = no positive affect shown; 7 = constant positive affect - smiling and laughing throughout task); parent negative affect (1 = no negative affect shown; 7 = constant negative affect - always scowling/frowning, voice always in harsh tones); parent responsiveness (1 = never responds - ignores child's comments, questions, and behaviours; 7 = always responds immediately to child; expands on comments made by child); parent on-task persistence (1 = no interest in task; no initiative; does not begin task; 7 = constant interest and persistence; always on-task); parent verbalization (1 = none; 7 = no distinct moments of silence); child positive affect (1 = no positive affect shown; 7 = constant positive affect - smiling and laughing throughout task); child negative affect (1= no negative affect shown; 7 = constant negative affect - always scowling/frowning, voice always in harsh tones); child responsiveness (1 = never responds; ignores parent's comments, questions, and behaviours; 7 = always responds immediately to parent; expands on some comments made by parent); child on-task persistence (1 = no interest in task; no initiative; does not begin task; 7 = constant interest and persistence; always on-task); child non-compliance (1 = always does what is asked by parent during task; 7 = non-compliant throughout task; always refuses or does something contrary to that which is asked of him/her; no instances of compliance); dyadic conflict (1 = no evidence of mutual conflict; 7 = high proportion of mutual conflict throughout the task); and dyadic reciprocity (1 = no evidence of reciprocity; 7 = highly integrated and reciprocal - constant shared positive affect and eye contact that never loses "turn taking" quality). Due to the age of the children in the study and the fact that the children were usually sitting on their parents' lap, making eye-contact difficult, the dyadic reciprocity code was altered slightly to include joint attention, positive interactions and turn-taking as key elements of this dimension. One researcher coded both interaction tasks

(i.e., digital and non-digital) separately for all 56 dyads, and then a second coder double-coded 25% of the sample (n = 14 dyads). The intraclass correlation coefficients ranged from 0.70 to 0.74 for digital and non-digital conditions respectively, showing a good level of agreement between the coders, with an overall intraclass correlation coefficient of 0.72.

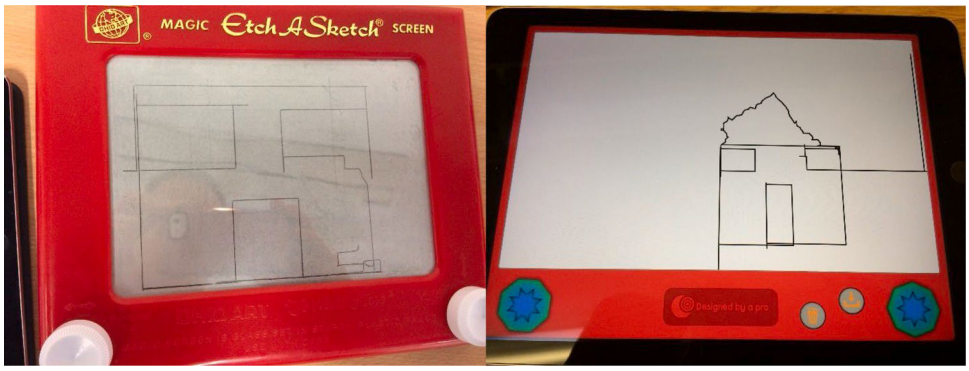
We observed moderate to substantial associations between behavioural dimensions and thus explored composite scores by conducting a principal axis factor analysis with oblique rotation (direct oblimin) on the 14 codes for both the digital task and non-digital task. In each condition this yielded 3 factors: cooperation, warmth and conflict. Cooperation comprised 5 parent codes (positive content, negative content, responsiveness, on-task persistence, and verbalisations), 3 child codes (responsiveness, on-task persistence, and non-compliance), and 1 dyadic code (reciprocity) and had a Cronbach's alpha of 0.91 for the digital task and 0.93 for the non-digital task. Parent negative content and child non-compliance were reversed scored so that high scores reflected higher levels of cooperation. Warmth was derived from 2 codes, parent positive affect and child positive affect, and had a Cronbach's alpha of 0.66 for the digital condition and 0.58 for the non-digital condition. High scores on the warmth scale reflected high levels of warmth. Conflict was derived from dyadic conflict and child negative affect. High scores on the conflict scale indicate high levels of conflict within the parent-child dyad and had a Cronbach's alpha of 0.58 for the digital condition and 0.72 for the non-digital condition. Child negative affect did not load well onto any of the factors and was thus not included in further analysis.

Procedure

The participants took part in a battery of tasks, of which the two interaction tasks were always the last and the tower building task was always first. While children completed a number of warm-up tasks, including the tower building, parents completed the communication section of the Ages and Stages Questionnaire (ASQ; Squires et al., 2009).

They were also asked to fill out an online questionnaire before they arrived which contained questions related to theirs and their child's demographics and their child's daily use of mobile touchscreen technology.

Figure 1. An Example of one Dyad's Output on the Etch-A-Sketch Toy and on the Etch-A-Sketch Tablet Application.



The interaction tasks comprised two 3-minute activities. In one condition parents and children were asked to work together to draw a picture of a house using an Etch-A-Sketch (the non-digital task) and in the other condition they were asked to do the same drawing but using an Etch-A-Sketch app on a tablet (the digital task). *Figure 1* illustrates both versions of the task with the toy version on the left and the app version on the right. The toy Etch-A-Sketch was of a similar size to the tablet and consisted of a drawing window surrounded by a red frame. In order to produce a picture in the drawing window two white dials at the bottom of the frame, one in each corner, needed to be rotated clockwise and anti-clockwise in order to move the drawing line vertically and horizontally. Shaking the Etch-A-Sketch deleted the drawing. The tablet Etch-A-Sketch app looked and operated in a very similar fashion (see *Figure 1*) but with two green and blue circles instead of the two white dials on the Etch-A-Sketch toy. Moving a finger clockwise and anti-clockwise around the inside of the circles moved the drawing line on screen vertically and horizontally. A

button on screen was used to delete the picture on the tablet app. Thus, although the dials on the tablet and on the Etch-A-Sketch required different aspects of motor control (gripping and turning versus circular finger movements), the essence of the two tasks were the same. Although it was anticipated that children's fine motor abilities would make the tasks challenging if they performed them alone, the key aim was for parents and children to work together, and so it was important to pick tasks which would be challenging enough to require parental support. Because parents were asked to work with the children on the tasks, and to therefore scaffold their level of help according to their child's needs, the tasks were expected to be of a similar level of difficulty when operating as a dyad.

The two tasks were performed back-to-back but were counterbalanced with half of the dyads performing the digital interaction task first and half the non-digital interaction task first. Before each of the two interaction tasks commenced, the researcher explained what the task involved and provided a demonstration of how to use the Etch-A-Sketch toy and the Etch-A-Sketch app.

All tasks took place in an observation lab (approximately 3m × 5m) with cameras in the corners of the ceiling. The lab is design for developmental research and contains furniture and toys reflective of the home environment including a sofa and child-sized table and chairs. The study was conducted in accordance with The British Psychological Society's Code of Ethics and Conduct (2018) and was approved by the University's Faculty Ethics Committee for Social and Applied Sciences.

Results

Preliminary analysis

In order to use age as an independent variable in subsequent analysis and ensure equal sample sizes, we used the median split to divide the children into two groups (see *Table 1* for an overview of the age range in each group): 'younger' toddlers (all those aged

under 31.5 months) and 'older' toddlers (all those aged over 31.5 months). Next, we checked for associations between our three dependent variables (cooperation, warmth, and conflict) and children's daily use of digital touchscreen technology, parental age, and parental education. The preliminary analyses revealed that children's daily use of digital technology, but neither parental age nor parental education, significantly covaried with measures of parent-child interaction. Therefore, daily usage was included in further analysis but not parental age nor parental education.

Table 1. Age Range (in Months) for Younger and Older Toddler Groups.

	Younger Toddlers	**Older Toddlers**
Minimum age	24 months	32 months
Maximum age	31 months	45 months
Mean age	27.7 months	37.3 months
Standard Deviation	1.9 months	4.1 months
n	28	28

Main analysis

Means and standard deviations for all dependent variables by condition and age can be seen in *Table 2*. Mean scores for cooperation and warmth were higher in the non-digital condition compared to the digital condition, whereas evidence of conflict was slightly higher during the digital task compared to the non-digital task.

In order to investigate whether the differences between the digital and non-digital tasks were significant, a 2 (Task: Digital versus Non-Digital) × 2 (Age: Younger versus Older) mixed MANCOVA was conducted, with Task as the within participants variable, Age as the between participants variable, and Daily Usage as a covariate. Using listwise deletion the sample size was reduced to n = 52 (n = 24 younger children; n = 28 older children) for the analysis as four of the participants did not provide information on Daily Usage.

Results revealed that daily usage was a significant covariate, $F(3, 47) = 3.28$, $p = 0.029$, $\eta p^2 = .17$, observed power = .714. However, over and above daily usage main effects were found for Task, $F(3, 47) = 6.77$, $p = 0.001$, $\eta p^2 = .30$, observed power = .97, and Age, $F(3, 47) = 3.49$, $p = 0.023$, $\eta p^2 = .18$, observed power = .74. A significant Task × Age interaction was also found, $F(3, 47) = 3.36$, $p = 0.026$, $\eta p^2 = .18$, observed power = .73. Next, separate univariate tests, each controlling for daily usage, were conducted on each dependent variable. All pairwise analyses were performed using a Bonferroni correction.

Table 2. Means (and Standard Deviations) for each Dependent Variable for Digital and Non-Digital Conditions and Younger- and Older-Toddler Groups.

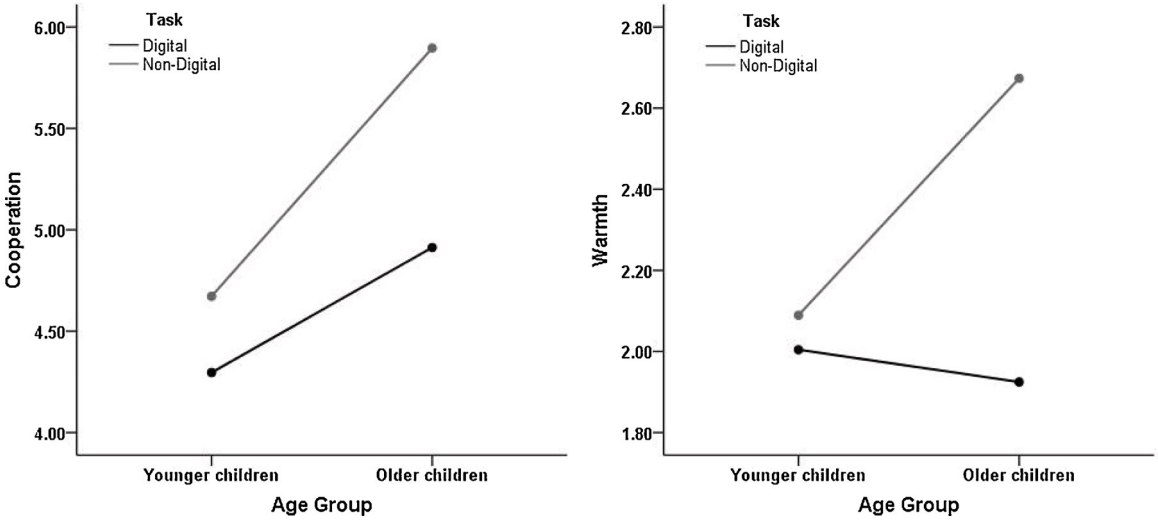
	Measure			
Task	**Dyad**	**Cooperation**	**Warmth**	**Conflict**
Digital Task	**Younger Toddlers**	*M* = 4.3 (*SD* = 1.4)	*M* = 2.0 (*SD* = 1.1)	*M* = 1.2 (*SD* = 0.5)
	Older Toddlers	*M* = 4.9 (*SD* = 1.1)	*M* = 1.9 (*SD* = 1.0)	*M* = 1.2 (*SD* = 0.4)
	Total	*M* = 4.6 (*SD* = 1.3)	*M* = 2.0 (*SD* = 1.0)	*M* = 1.2 (*SD* = 0.4)
Non-Digital Task	**Younger Toddlers**	*M* = 4.7 (*SD* = 1.4)	*M* = 2.1 (*SD* = 1.0)	*M* = 1.1 (*SD* = 0.3)
	Older Toddlers	*M* = 5.9 (*SD* = 0.8)	*M* = 2.7 (*SD* = 1.0)	*M* = 1.0 (*SD* = 0.1)
	Total	*M* = 5.3 (*SD* = 1.2)	*M* = 2.4 (*SD* = 1.1)	*M* = 1.1 (*SD* = 0.2)

Cooperation

There was a significant main effect of Task on cooperation, $F(1, 49) = 19.26$, $p < 0.001$, $\eta p^2 = .28$, observed power = .99, with parent-child dyads engaging in significantly more cooperation during the non-digital task ($M_{adj} = 5.3$, $SE = 0.15$) than during the digital task ($M_{adj} = 4.6$, $SE = 0.18$), $p < 0.001$, $d_{Cohen} = 0.59$. There was also a main effect of Age on

cooperation, $F(1, 49) = 9.04$, $p = 0.004$, $\eta p^2 = .16$, observed power = .84, where dyads comprising older toddlers engaged in significantly more cooperation ($M_{adj} = 5.4$, $SE = 0.21$) than the younger toddler dyads ($M_{adj} = 4.5$, $SE = 0.23$), $p = 0.004$, $d_{Cohen} = 0.80$. In addition, there was a significant Task × Age interaction, $F(1, 49) = 7.29$, $p = 0.010$, $\eta p^2 = .13$, observed power = .75, in which there was significantly more cooperation in the digital condition among older-toddler dyads ($M_{adj} = 5.9$, $SE = 0.21$) than younger-toddlers dyads ($M_{adj} = 4.7$, $SE = 0.22$), $p < 0.001$, $d_{Cohen} = 1.10$ (see *Figure 2*).

Figure 2. Task by Age Interaction Effects for Cooperation and Warmth.



Warmth

There was a significant main effect of Task on warmth, $F(1, 49) = 6.37$, $p = 0.015$, $\eta p^2 = .12$, observed power = .70, with dyads displaying significantly more warmth during the non-digital task ($M_{adj} = 2.4$, $SE = 0.14$) than during the digital task ($M_{adj} = 2.0$, $SE = 0.14$), $p = 0.005$, $d_{Cohen} = 0.40$. While there was no significant main effect of Age on warmth, there was a significant Task × Age interaction, $F(1, 49) = 5.42$, $p = 0.024$, $\eta p^2 = .10$, observed power = .63, in which dyads with older toddlers demonstrated significantly more warmth during the

non-digital task (M_{adj} = 2.7, SE = 0.18) than the same dyads during the digital task (M_{adj} = 1.9, SE = 0.19), $p < 0.001$, d_{Cohen} = 0.82. In addition, older-toddler dyads (M_{adj} = 2.7, SE = 0.18) showed significantly more warmth than younger-toddler dyads (M_{adj} = 2.1, SE = 0.20), p = 0.036, d_{Cohen} = 0.62 during the non-digital task (see *Figure 2*).

Conflict

There were no main effects of Task, $F(1, 49) = 1.85$, p = .179, ηp^2 = .04, observed power = 0.27, nor Age, $F(1, 49)$ = .94, p = 0.336, ηp^2= .02, observed power = .16., nor a Task × Age interaction, $F(1, 49)$ = .03, p = 0.855, ηp^2 = .001, observed power = .05 for conflict.

Post hoc exploratory analyses

In order to investigate whether differences observed between the older and younger toddlers might be related to developmental milestones in fine motor or communication abilities, exploratory correlations were performed using the tower building and ASQ communication measures (see *Table 3*). Overall, children's fine motor ability showed a small but significant positive correlation with the level of cooperation shown on the tasks both overall (r_s = 0.31, p = 0.025) and during the digital task specifically (r_s = 0.33, p = 0.019). This suggests that the more advanced the children's fine motor development was, the more likely the dyads were to show cooperation on the interaction tasks, particularly in the case of the digital task. Similarly, the children's ASQ communication scores also showed a small but significant positive correlation with the cooperation scores for the digital task (r_s = 0.28, p = 0.037). Again, this suggests that the children's communication were associated with the level of cooperation the dyads showed during the digital task.

Interestingly, there was also a small but significant negative correlation between the children's communication abilities and the level of warmth shown on the non-digital task (r_s = - .265, p = 0.048). That is, the lower the children's communication skills, the warmer the interaction was within the dyads on the non-digital task.

Table 3. Correlations Between Dyadic Cooperation and Warmth and Fine Motor and Communication Development both Overall and in the Digital and NonDigital Tasks Individually.

		Block Task		ASQ Communication	
Variable	**Task**	***p* value**	**r_s**	***p* value**	**r_s**
Cooperation	**Digital**	.019	.33	.037	.28
	Non-Digital	.055	.27	.375	.12
	Both	.025	.31	.082	.23
Warmth	**Digital**	.401	.12	.952	.01
	Non-Digital	.668	.06	.048	-.27
	Both	.505	.10	.141	-.20

Discussion

The current study directly compared parent-child interaction in digital and non-digital conditions on a drawing task performed either on an Etch-A-Sketch toy or using an Etch-A-Sketch app on a tablet. This allowed a direct comparison between interactional contexts, over and above task effects and individual differences in the quality of dyadic relationships. We found that interactions were more cooperative and warmer in the more traditional toy condition than they were in the tablet condition, across both younger and older toddlers, even when the level of children's daily use of digital touchscreen media was taken into account. There was also a significant interaction between task and age, in which both cooperation and warmth were highest for older toddlers in the non-digital condition, and cooperation in particular was lowest for younger toddlers in the digital condition. In the toy condition warmth increased with age whilst in the digital condition warmth remained low in comparison and was not related to toddler age. This is the first evidence of differences in parent-child interactions between digital and traditional contexts across the toddler years. Our findings suggest that interacting around digital technology may be a more challenging context for parents and toddlers, with interactions in the current study

less warm and less cooperative than in the more traditional toy context. There were also age-related differences between younger and older toddlers. However, we do add a note of caution in relation to age-related differences as our older toddler group contained a wider age range (13.5 months), than our young group (7.5 months) and therefore may have represented a broader developmental spectrum of ability.

These findings suggest that the quality of parent-child interactions may be poorer when parents are engaged in joint activity around digital screen media, particularly with very young toddlers, than they are in more traditional contexts. This replicates findings of older children engaged in digital versus traditional book reading with parents and extends our understanding of parent-child interaction to a wider range of contexts involving joint media engagement. For example, Yuill and Martin (2016) found e-books were less conducive to sharing as children tended to use these in a more individualistic way, by leaning over the screen with head down and holding the device in both hands which resulted in less interactional warmth between parent and child during the activity. In our study, the task required both parents and children to share the screen and toy in order to replicate the picture cooperatively and thus presented a different type of set-up. Most children sat on parents' laps whilst completing the task; such close proximity is usually a set-up that is reflective of warm, responsive interactions (Deater-Deckard, Pylas, & Petrill, 1997). However, we noted less warmth and more frustration between parents and children during the digital task. Children appeared to find the digital dial more challenging to manipulate than the physical Etch-A-Sketch dials which resulted in parents often having to hold both the tablet and help the child to manipulate the dial. These features made the digital condition more challenging and more frustrating for parents and children, evidenced in lower levels of warmth and cooperation, than those observed when dyads were engaged in the physical, non-digital, version of the same task. In part then, although the requirements of the task were similar, the affordances of the digital device meant the

parent-toddler dyads experienced higher levels of frustration and less warmth in their interactions when using the tablet than they did when engaged in the toy version of the same task.

Furthermore, while cooperation did increase with age, it was still significantly lower in the digital condition than the non-digital condition even for the older toddlers, suggesting something unique about the digital context over and above developmental limitations. While touch interaction can be more intuitive for toddlers (Ahearne et al., 2016), limitations in fine motor ability can still limit meaningful engagement which has important implication for design and development of age-appropriate applications. The positive associations evident between cooperation and fine motor and communication abilities were significant in the digital but not the non-digital condition. This adds further support to the suggestion that interactions around digital media represents a unique context for parent-child interaction. While these are clearly associated with developmental milestones, parent-child interaction around digital devices appears to be of a poorer quality than interactions for the same dyads in more traditional contexts. In part, this may be due to more opportunities for conflict and disagreement being available in tasks that require more active participation. However, while this may explain differences between interactive media, such as touchscreens, and more passive media such television viewing, in the current study we used an equally active task comparable in levels of engagement across both digital and non-digital conditions.

This has important implications for parents who are encouraged to become co-users of digital technology with their very young children (American Academy of Pediatrics, 2016; Galpin & Taylor, 2018). Although digital technologies are pervasive in the home environment (Chaudron, 2015), we know parents are less likely to co-use digital media with children than they are with more traditional technologies (e.g., television) (Connell et al., 2015). Our evidence suggests that digital contexts may be more challenging and more

emotionally charged for parents and toddlers when compared to more traditional interactional environments. However, further research is needed to develop a more nuanced understanding of the mechanisms and dynamics at play in this context. For example, future research should attempt to link patterns of interaction with outcomes including age-related changes in ability, in more naturalistic environments such as in the home. Understanding these dimensions will enable us to provide additional support for parents and guidance on effective joint activity using digital technology.

While the repeated measures design of this study allowed us to control for individual differences in relationship quality and interactional style within our sample of parent-child dyads, the sample itself was highly homogeneous with little diversity in parental education, ethnicity or family structure. We know that such variables play an important role in how families use screen media at home (Lauricella et al., 2015). In particular, parental education is an important predictor of parents' likelihood of co-using digital technology with children within the home (Levine et al., 2019). Thus, future research is needed to examine parent-child interactions in families from a broader range of socio-economic and cultural backgrounds during co-use of digital technology. A further limitation of the study was the under-representation of father-toddler dyads; only four fathers participated in the interaction tasks, with the vast majority of observations focusing on mother-toddler dyads. There is evidence to suggest that in fact fathers may spend more time at home engaged in co-use of computers and smartphones with children than mothers (Connell et al., 2015). Furthermore, there is a broad literature on fathers' and mothers' interactional style (Lewis & Lamb, 2004). Thus, future research including fathers has the potential to uncover variations in parent-child interactions around digital media reflecting wider family processes. Finally, comparisons made in relation to parent-child conflict in digital versus non-digital conditions did not reach sufficient power for us to draw

conclusions. Future research can address these limitations by using both a larger and a more diverse sample.

Despite these limitations, the current study has provided novel experimental evidence of differences in the quality of parent-child interactions when parents co-use touchscreen technology with very young children. Interactions around the technology were less cooperative and less warm than those using a more traditional toy to perform the same task. Younger-toddler dyads found the digital context particularly challenging, in part due to fine motor and communication limitations. The results have implications for developing more nuanced guidance and support for parents in order to address the challenges of supporting very young children's use of digital media.

Author contributions

Conceptualization, A.C.; methodology, A.C.; software, N/A; validation, A.C.; formal analysis, A.C. and T.D.; investigation, T.D.; resources, A.C. and T.D.; data curation, T.D.; writing - original draft preparation, A.C. and T.D.; writing - review and editing, A.C. and T.D.; visualization, A.C. and T.D; supervision, A.C. and T.D. ; project administration, A.C. and T.D.; funding acquisition, A.C.

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Declaration of Competing Interest

The authors declare no conflict of interest.

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