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# Daily Parent-Adolescent Digital Exchanges

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## Abstract

The present study tracked adolescents via mobile phones to describe how parents and their adolescent children are using digital technologies in daily life (i.e. facilitating warmth and behavioral control), and whether these uses are associated with the quality of offline parent-adolescent interactions and with adolescents' mental health. A sample of young adolescents (N=388; mean age 13.37) completed a 14-day ecological momentary assessment in 2016– 2017, reporting on their daily digital contact and offline interactions with their parents and their mental health. Adolescents reported using texting and calling to communicate somewhat infrequently with their parents (i.e., on 29% of days), but days with more digital contacts (for both warmth and behavioral control) were also more likely to be characterized by more positive offline interactions with parents. Furthermore, adolescents struggling with mental health symptoms across the study period reported using texts/calls more frequently to seek out parent support, and parents were more likely to do text/call "check ins" on young people who were experiencing more behavioral problems. Results highlight the potential for the digital communication devices to be used as tools in fostering parent-adolescent connection, support provision, and behavioral control in the digital era.

### Keywords

Adolescence; Mobile phones; Mental health; Behavioral control; Warmth



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Parents and their adolescent children are increasingly connected via mobile technologies, which is not surprising given that mobile phone ownership among parents and teens is nearly universal (Anderson and Jiang 2018). Although the negative aspects of digital device use are often considered in family contexts (e.g. as distractions in parent-child interactions and as a source of conflict; Coyne et al. 2017; Zhang and Livingstone 2019) digital communication devices may also serve as *tools* that aids in the traditional tasks of parenting (Kennedy et al. 2008; Common Sense Media 2016). The present study examined daily parent-adolescent digital communication, as reported each day via mobile phone by young adolescents. Key aspects of parent-child interactions identified by parenting theory and past empirical studies of in-person parent-child relationships (e.g. Baumrind 1966) as most important for supporting positive youth mental health and behavior were assessed as they were expressed in digital communication, including: parental warmth (which includes both engagement and support) and parent behavioral control (which includes limit setting/rule enforcement and monitoring of child's activities and behaviors).

## Digital Communication as a Tool for Parent-Adolescent Interaction

Growing numbers of family members report that digital communication can be used in the tasks of parenting and to enhance parent-child connections (Kennedy et al. 2008; Williams and Merten 2011; Common Sense Media 2016). As early as 25 years ago, researchers realized that phones permitted what they called "remote mothering", allowing mothers to serve in domestic and work roles at the same time (Rakow and Navarro 1993). A decade ago, US parent-teen dyads (ages 13–16) were reporting 2–3 calls to and from parents per day (Weisskirch 2009), with up to 42% of parents (of children ages 7–17) reporting *daily* cellular phone contact with their child (Kennedy et al. 2008). Today, mothers still report that the mobile phone is a useful tool in achieving parenting goals (Walker and Rudi 2014), with 35% of parents reporting that technology makes parenting easier in a representative sample of nearly 1,800 US parents (Lauricella et al. 2016). The mobile phone has rapidly become an integral part of family communication in the United States and elsewhere: In a large comparison of mobile-phone owning children in European countries and Japan, parents retrospectively reported nearly daily parent-child phone contact occurred via voice calls among 54.3% (from 6.7% in Japan to 77.2% in Italy) and via messaging among 39.9% of children (from 10.9% in Japan to 55.1% in Portugal; DOCOMO, 2014).

There have been fewer recent representative studies of quantity/frequency of parent-child digital contact in the US, though in a 2015 study of more than 1000 US teens, 90% of parents reported using messaging to communicate with their children aged 13 to 18 ( Rudi et al., 2015). Across the early 2000s to present day, the purpose of these phone contacts have consistently included many of the traditional or mundane tasks of parenting, including monitoring and checking in on children when they are outside the home, inquiring about the day's events, and coordinating logistics like pickup and changed plans (Kasesniemi and Rautiainen 2002; Racz et al. 2017; Fletcher et al. 2018).

## The Co-Construction of Online and Offline Parenting

Contemporary adolescents are more digitally connected than ever before, but we are lacking a nuanced understanding of what types of parent-adolescent digital interactions are the most effective in facilitating wellbeing. The present study takes a "co-constructionist" approach to understanding the use of digital communication in parenting, which suggests that online and offline (parenting) behaviors often mirror and impact one another, and that neither the online nor the offline sphere exists independently (Subrahmanyam et al. 2006). Those parenting behaviors which we know are beneficial in face-to-face interactions may also be effective when delivered digitally, and we thus focus on parental warmth and behavioral control.

In the offline sphere, many studies have shown that low levels of parental warmth are associated with both internalizing and externalizing problems and that, conversely, high levels of warmth are protective against these problems (Garber et al. 1997; Shaw et al. 1998; Gray and Steinberg 1999; Hammen et al. 2004). Behavioral control has likewise been seen historically as protective against externalizing symptoms in particular (Dishion et al. 1991; Gray and Steinberg 1999; Racz and McMahon 2011), with some evidence to support linkages with fewer internalizing problems as well (Kurdek and Fine 1994; Galambos et al. 2003). Scholars highlight the importance of distinguishing between different facets of behavioral control, honing in on the distinction between child disclosure of information, parental solicitation of information, and parental control/rules and expectations (all of which serve to increase parental knowledge of youth's whereabouts and activities; Stattin and Kerr 2000). Specifically, some evidence has suggested that adolescents' self-disclosure on their whereabouts and behaviors is more strongly tied to lower rates of problem behaviors than is parental solicitation about these same behaviors (Kerr and Stattin 2000; Racz and McMahon 2011). Further, the linkages between problem behavior and parental solicitation or control have been contradictory; at times linked with both decreased (Kerr and Stattin 2000; Laird et al. 2010; Padilla-Walker et al. 2011) and increased (Kiesner et al. 2009; Willoughby and Hamza 2011) internalizing and externalizing risks. In reality the associations are likely to be bidirectional in nature whereby youth with the most mental health symptoms and behavior problems elicit increases in parental solicitations and attempts at control, while these parent behaviors also shape youth behavior (Laird et al. 2003; Lansford et al. 2018). In the present study we assess warmth and behavioral control as experienced and reported digitally each day by adolescents.

## Warmth in Parent-Adolescent Digital Exchanges

Parents and children both report that digital communication is useful in maintaining warm parent-adolescent relationships by building a sense of connection and through flexible provision of support. For example, in one study of 2,252 adults, 25% of parents reported feeling that their family was closer than their family of origin due to the internet and cell phones, and 47% felt that the quality of communications with members of their household was improved due to these new communication technologies (Kennedy et al. 2008). There is some evidence to suggest that phone engagement is associated with more positive parent-adolescent relationships: In a study of 196 parent-adolescent dyads, more frequent phone calls were associated with young peoples' perceptions of greater support and lower conflict

with parents (Weisskirch 2011). A recent qualitative study suggested that mobile phones may facilitate parent-youth emotional connections through social support seeking and allowing for communication in the moment it is needed (Fletcher et al. 2018), which complements previous work which suggested that that the mobile phone was an integral part of sharing day to day experiences, maintaining connection, and seeking emotional and physical support from parents (Chen and Katz 2009). Despite the fact that emotionally supportive interactions make up only a small portion of overall parent-child phone interactions (Fletcher et al. 2018), there is evidence that child support seeking via phone is associated with more parental perceptions of closeness (Weisskirch 2011).

## Behavioral Control in Parent-Adolescent Digital Exchanges

Keeping tabs on children and adolescents (i.e. monitoring and behavioral control) is one of the most frequently cited uses of the cell phone within the context of parenting, and is a primary reason that parents say they get their child a mobile phone (Haddon and Vincent 2014; Nielsen 2017). For instance, 80% of parents of 6–12 year-old children with a mobile phone report that they got it for them in order to track their location (Nielsen 2017), with 48% of US parents of 12–17 year old adolescents reporting using the phone to monitor their child's location (Lenhart 2012). In a sample of 158 US fathers, the preferred method of technologically mediated solicitations and disclosures was text messaging, followed by phone calls (Hessel et al. 2017). Notably, research has shown that parents who were high on technologically mediated monitoring were also high on monitoring face to face, which suggests that the phone may be used to *supplement* in-person parenting strategies rather than *supplant* them (Rudi and Dworkin 2018).

The mobile phone enables parents to exert control and surveillance over their children's activities even when they are not physically together, and can yield increased access to what was previously perceived as personal time and space (Williams & Williams, 2005). This type of mobile phone use can be perceived as invasive by youth, who report that parents can be intrusive or excessive in their cell phone contact (Racz et al., 2017). We also know that youth perceptions of over-control and privacy invasion are related to poorer parent-adolescent relationships (Hawk et al. 2009). Past research showed that parental knowledge and perceived adolescent truthfulness were maximized when the adolescent initiated phone contact; parent-initiated calls, in contrast, were associated with less truthfulness, and parent solicitations were associated with *less* parent knowledge and more parent-adolescent conflict (Weisskirch 2009, 2011). This suggests that, as with the in-person literature on behavioral control, adolescent-driven disclosures are the best avenue to parent knowledge and reflect a stronger parent-adolescent relationship, whereas those parent-driven behavioral control behaviors that are perceived as intrusive are less likely to increase parent knowledge and more likely to provoke family disharmony.

## Digital Communication in Parent-Adolescent Exchanges and Adolescent Mental Health

Parents and their children report using digital communication as a tool for connection, behavioral control, and support. However, there have been fewer investigations on how these

uses are related to adolescent mental health. Results from the few studies that have specifically examined parent-adolescent phone communication and behavioral outcomes are consistent with expectations from traditional parenting theories that, to the extent that communications facilitate connection, support, and adequate behavioral control—but avoid intrusiveness— they are associated with better psychosocial adjustment. For instance, daily diary studies have shown that days on which youth communicate with their parents via phone are more likely to be days with more positive health behaviors and less problem drinking (Small et al. 2011, 2013). However, a number of studies also suggest that technologically mediated contact is not always associated with better outcomes. In one study of US fathers, those fathers who communicated and solicited more information from their child's friends online had children with more internalizing and externalizing problems, and less prosocial behavior, which the authors suggest may be due to perceived intrusiveness of this type of communication (Hessel et al. 2017).

Another study showed that technology mediated monitoring did not seem to reduce substance use behaviors, and that those children whose parents monitored may even have been at greater risk compared to those parents that didn't use technology to monitor (Rudi and Dworkin 2018). It is possible that these positive associations between certain types of more intensive monitoring/behavioral control and child internalizing and externalizing difficulties may be indicative of a "squeaky wheel gets the grease" phenomenon, wherein those youth with existing behavior problems provoke parental monitoring using alternate strategies to attempt to reduce already risky behavior. It is also possible that differences in mental health outcomes for adolescents embedded in parent-adolescent dyads characterized by high versus low levels of parental behavioral control have little to do with parental behavioral control *per se* but are instead driven by other third factors such as family income or correlated genetic or familial propensities that influence both parenting behaviors and youth mental health.

## The Present Study

The present study uses Ecological Momentary Assessment (EMA) delivered directly to early adolescents via mobile phone multiple times daily over the course of two weeks to examine the role of digital communication in daily parent-adolescent exchanges and how it relates to the quality of offline parent-adolescent interactions and to adolescents' mental health. This real-time data collection is less susceptible to the biases of retrospective self-report, and allows us to differentiate within-person, "when", study questions (about same day co-occurrence of parent-adolescent digital exchanges for warmth and behavioral control with the quality of offline parent-adolescent interactions and mental health) from between-person, "who", study questions (about which adolescents and parents tend to engage in parent-adolescent digital exchanges more often, and whether those youth also tend to have better offline parent-adolescent interactions and mental health). It is important to parse these associations, as psychologists often fall prey to the ecological fallacy, incorrectly generalizing between-person findings to individual adolescents' experiences (Fisher et al. 2018).

First, the present study examines whether adolescents' digital exchanges with their parents differ by adolescent gender, race/ethnicity, and economic disadvantage (**Q1**: How frequently is digital communication used in parent-adolescent exchanges, and which adolescents engage in these parent-adolescent digital exchanges most?) The parent-adolescent digital exchanges are measured through adolescents' daily reports on whether they called or texted with a parent for the purpose of obtaining support, parents solicited information from the child, children disclosed information to the parent, or parents reminded the child of rules or expectations for behavior.

Second, we test whether increased parent-adolescent digital exchanges are associated with improved offline interactions between parents and their adolescent children, **Q2a:** Do adolescents report more positive offline parent-adolescent interactions (fewer hassles and more uplifts) on days when they report parent-adolescent digital exchanges? **Q2b:** Do adolescents who report more frequent parent-adolescent digital exchanges report more positive offline parent-adolescent interactions (fewer hassles, more uplifts) on average over the two-week EMA study period? Question 2 tests these associations both within-person (a) and between persons (b).

Third, we test whether parent-adolescent digital exchanges are promotive for adolescent mental health by answering the following study questions: **Q3a:** Do adolescents experience fewer mental health problems on days when they report parent-adolescent digital exchanges? **Q3b:** Do adolescents who report more frequent parent-adolescent digital exchanges experience fewer mental health symptoms, on average, over the two-week EMA study period? Question 3 tests these associations both within-person (a) and between persons (b).

Although study questions 2 and 3 are designed to yield useful information about the daily co-occurrence of parent-adolescent digital exchanges, offline interactions, and adolescent mental health, they do not yield any information about which processes might be driving others over time. Thus, we tested a fourth exploratory study question, **Q4.** Do the associations tested in Q3 (between parent-adolescent digital exchanges and offline-parent interactions) and Q4 (between parent-adolescent digital exchanges and adolescent mental health) persist to the next day?

## Method

### Sample and Procedure

A representative sample of children was recruited using administrative data from the North Carolina Department of Public Instruction and administered a Baseline Adolescent Survey ($N$ = 2,104) in 2015 when participants ranged in age from 9 to 15. The majority of parents gave permission to contact their child for future studies ($n$ = 1867, 88.7%). A subsample of 395 early to mid-adolescents participated in a Home Visit and a 14-day EMA in 2016–2017. Adolescents were selected based on their: 1) proximity to two geographically distinct locations (central, urban NC, and western, rural NC) from which staff could make in-person home visits (1275 adolescents eligible), and 2) representation to the statewide public-school population in terms of economic disadvantage, gender, race, and ethnicity. We recruited among this eligible sample until we reached the target N=400. The 395 adolescents who

agreed to participate in the EMA were fairly representative of the population, though more likely to be White (60.6% versus 51.3%) and less likely to be economically disadvantaged (measured as receipt of free/reduced lunch; 40.8% versus 55.4%) compared to the overall state public school population. Reasons for refusal/non-participation included opting out for various reasons, out of date contact information, and no longer living in the eligible geographic radius. Of the 395 adolescents who completed the home visit, 388 adolescents completed at least one EMA survey for the present study and comprise our analysis sample (70% of participants answered ≥ 70% of prompts). The vast majority of the EMA sample (94%) fell between the ages of 12–15 (full range= 10–17 years of age). All procedures were approved by the Duke University Institutional Review Board (#D0396).

The Home Visit was conducted by two interviewers who installed a survey application (MetricWire Inc. 2016) on either the participant's own smart phone (49.9%) or a study-provided smart phone (which was not equipped with texting or calling capabilities) and walked them through a practice survey with a take-home reference guide. Participants received $1 per EMA survey completed, with those with at least 80% compliance receiving the full $42. For each day of the 14 days that participants completed all three surveys (in the morning, afternoon, and evening), they were entered into a drawing to win a wearable fitness tracker used in the study. Eighty percent of prompts were answered, yielding 13,017 observations over 5,270 study days.

## Measures

**Daily offline parent-adolescent interactions.—**During the EMA, adolescents reported daily (afternoon and evening) on the occurrence or absence of 6 different *parent hassles* (e.g. "argued with a parent", "parents were too nosy", "parents didn't help me", "people at home were stressed", "there was too much chaos at home", "something else stressful") and 6 different *parent uplifts* (e.g. "had fun with my family", "parents were happy with me", "parents let me do what I wanted", "parents helped me", "parents got me something I wanted", "something else positive"). These items did not differentiate with which parent these interactions occurred and were adapted to daily adolescent experiences from existing stress inventories (Ham and Larson 1990; Kearney et al. 1993; Shahar et al. 2003; Evans et al. 2009). Responses were dichotomized at the daily level to yield indicators of the presence (1) or absence (0) of parent hassles, and uplifts were summed to yield a count of the parent uplifts experienced each day. Person-means were computed by averaging these daily measures across the entire EMA, with person-means reflecting the proportion of days on which adolescents experienced hassles ($M$=.182, $SD$=.117) and the number of parent uplifts experienced on an average day ($M$=1.78, $SD$=1.12; $\alpha$ =.78).

**Daily parent-adolescent digital exchanges for warmth and behavioral control.—**In the EMA, adolescents reported daily (afternoon and evening) on whether or not they had called or texted with their parents for the following purposes: *support seeking* ('I texted or called my parents to ask for advice or help'), *solicitation* ('my parents texted or called to ask where I was, who I was with, or what I was doing'), *disclosure* ('I texted or called my parents to tell them who I was with or what I was doing'), or *control* ('my parents texted or called to remind me of the rules (like my curfew, chores, or homework)'). These items did

not differentiate with which parent these exchanges occurred. Responses were dichotomized at the daily level to yield indicators of the presence (1) or absence (0) of each type of parent-adolescent digital exchange that day. A measure of any daily digital *engagement* was created with a score of 1 assigned if the child endorsed communicating with parents 'just to chat', for any of the reasons above, or responded negatively to 'I did not text or call my parents'. Person-means were computed by averaging these dichotomous daily measures from the EMA; person-means reflect the proportion of days on which adolescents reported each type of parent-adolescent digital exchange).

**Daily mental health.—**Adolescents' daily levels of *inattention and hyperactivity* were assessed with four EMA-adapted questions from studies of attention-deficit hyperactivity in children (Whalen et al. 2011), assessing the presence of attention difficulties (e.g. "I'm having a hard time concentrating or focusing", morning, afternoon, and evening; "I'm having a hard time finishing things"; afternoon and evening), hyperactivity ("So far today, I've felt restless or like I was always 'on the go", afternoon and evening), and impulsivity ("I've been doing things without thinking first"; morning, afternoon, and evening). Items were dichotomized at the daily level to reflect the presence or absence of each symptom that day, and a daily symptom count computed. Person-means were computed by averaging the daily measures across the study period and reflect the average number of symptoms across all days ($M$=.82, $SD$=.88; α =.83). *Conduct problems* were assessed with seven (yes/no) questions in the afternoon and evening about whether adolescents engaged in aggressive and deviant behavior (e.g., "So far today, I took or stole something that didn't belong to me"). Due to the low base rates of the fairly serious conduct problems queried, responses were dichotomized at the daily level to yield indicator of the presence (1) or absence (0) any conduct problems that day. Person-means were computed by averaging the daily measures across the study period and reflect the proportion of days on which adolescents endorsed a conduct problem ($M$= .08, $SD$=.17, α =.72).

Adolescents responded to items from the Positive and Negative Affect Schedule for Children (Laurent et al. 1999) in the morning, afternoon, and evening. *Depressive* symptoms were measured by asking adolescents to use a slider scale to indicate whether they felt "sad", "tired", and "lonely," on a scale ranging from 1 (not at all) to 100 (very). These three items were chosen for their overlap with DSM-5 criteria (sadness and tiredness/fatigue) and for strong correlations with depression in adolescence (loneliness; Lasgaard et al. 2011) and were averaged across the day to yield a daily depressive symptom score. A core symptom of anxiety (*worry)* was assessed using the same slider scale to respond to a question asking adolescents to indicate whether they were "worried about something" (averaged across the day to yield a daily worry score). Person-means were computed by averaging daily depressive symptoms ($M$=21.34, $SD$= 12.48; α =.69) and daily worry ($M$=18.32, $SD$= 12.48) across all study days. In past research in this sample (Jensen et al. 2019), these daily measures of mental health symptoms correlated as expected with well-validated measures of risk factors including conduct problems (Miller-Johnson et al. 2004), effortful control (Ellis and Rothbart 2001), and psychological distress (Furukawa et al. 2003).

**Covariates.—**At the Baseline Adolescent Survey adolescents reported their birthdate, *gender*, race, and Hispanic ethnicity. *Race/ethnicity* was re-coded into four categories reflecting White (not-Hispanic; 59.79% of sample), Black (not-Hispanic; 19.07% of sample), Hispanic (of any race; 12.89% of sample), and other race/ethnicity (including Asian, American-Indian, Native Hawaiian/Pacific Islander, multiracial, and those who did not report on race/ethnicity; 8.25% of sample). *Age* was calculated based on self-reported birthdate and the date of the first EMA survey ($M_{\text{ageEMA}}$ = 13.37, $SD$ = 1.14). Family *economic disadvantage* was determined based on eligibility for free and/or reduced lunch using school administrative records. Schools use verified household income to determine eligibility; cutoffs vary with household size and are on the order of 175% the federal poverty level. Those families who were persistently eligible for free or reduced lunch across all years for which administrative data is available (2009–2016) are classified as economically disadvantaged (31.07% of the sample).

Adolescents reported daily in the evening on whether they attended school that day (0=attended school, 1= no school). This daily *school attendance* covariate is included in multilevel models to account for potential weekend effects (Przybylski and Weinstein 2017) and third variable confounding (i.e. adolescents may report different levels of parent-adolescent digital exchanges, offline parent-adolescent interactions, and even mental health symptoms during unstructured time on non-school days). A person-mean of school attendance was computed across the study and reflects the percentage of days school was not attended (higher= more days out of school) and is included as a level 2 covariate to account for summer and school break seasonality (i.e. in summer a student would report 100% days off school).

## Data Analyses

Study questions were tested in the EMA sample (N=388). We parsed within-person daily and between-person variation by leaving the measures of parent-adolescent digital exchanges in uncentered (raw) form, while accounting for the difference in average use of these same measures (across days). In contrast to a person-mean centering approach, this technique facilitates interpretation of types of digital communication (level 1 predictors) in their natural metrics (occurrence/non-occurrence of digital exchanges) such that the zero point represents a day with no parent-adolescent digital exchanges, while still accounting for the fact that some families engage more or less in digital exchanges than other families overall. With this specific centering strategy, the level 1 association is the *within-person* association, revealing the difference in offline parenting outcomes across high versus low digital parenting days for the average adolescent, and the level 2 association is the *between-person contextual association*, revealing whether being an adolescent who tends to experience high versus low digital parenting is associated with a tendency to also experience more positive /negative offline exchanges, over and above the within-person association.

**Q1.—**To our knowledge, this is the first study to assess daily occurrence of parent-adolescent digital exchanges for warmth and behavioral control, and thorough description is warranted. We examined frequencies of parent-adolescent digital exchanges in SAS 9.2. We

also tested for demographic differences (by age, gender, race/ethnicity, and economic disadvantage).

**Q2.—**We examined associations between daily parent-adolescent digital exchanges interactions and daily offline parent-adolescent interactions (hassles and uplifts) in two-level models (a separate model for each predictor-outcome pair):

$$\begin{aligned}\text{Level 1: } \text{OfflineInteractions}_{ij} = {} & \beta_{0j} + \beta_1(\text{dDigitalExchange}_{ij}) + \beta_2(\text{dSchoolDay}_{ij}) \\ \text{Level 2: } \beta_0 = {} & \gamma_{00} + \gamma_{01}(\text{mDigitalExchange}_j) + \gamma_{02}(\text{mSchoolDay}_j) \\ & + \gamma_{03}(\text{Age}_j) + \gamma_{04}(\text{Gender}_j) + \gamma_{05}(\text{Disadvantage}_j) \\ & + \gamma_{06}(\text{Black}_j) + \gamma_{07}(\text{Hispanic}_j) + \gamma_{08}(\text{Other}_j) + \upsilon_{0j}\end{aligned}$$

Level 1 modeled daily parent-adolescent offline interactions (parent hassles and uplifts separately) for day *i* and person *j* as a function of a person-specific intercept term ($\beta_{0j}$), daily parent-adolescent digital exchanges ($\beta_{2;}$ $\text{dDigitalExchange}_{ij}$), whether the student went to school that day ($\beta_{2;}$ 0=school day and 1= no school), and a residual term ($\varepsilon_{ij}$). Level 2 modeled the person-specific intercept as a function of person-average parent-adolescent digital exchanges ($\gamma_{01;}$ $\text{mDigitalExchange}_j$), average non-school days ($\gamma_{02}$; the percentage of study days not in school, to account for summer and school break seasonality), person-level covariates ($\gamma_{03\text{-}}$ $\gamma_{08}$), and a random person-specific error term ($\upsilon_{0j}$). The binary nature of daily parent hassles was modeled using multilevel logistic regression, estimating the Log Odds of reporting a parent hassle and thus did not include a level 1 residual term.

**Q3.—**We examined associations between daily parent-adolescent digital exchanges and daily mental health (conduct problems, symptoms of inattention/hyperactivity, depressive symptoms, and worry) in separate multilevel models:

$$\begin{aligned}\text{Level 1: } \text{MentalHealth}_{ij} = {} & \beta_{0j} + \beta_1(\text{dDigitalExchangel}_{ij}) + \beta_2(\text{dSchoolDay}_{ij}) + \varepsilon_{ij} \\ \text{Level 2: } \beta_0 = {} & \gamma_{00} + \gamma_{01}(\text{mDigitalExchange}_j) + \gamma_{02}(\text{mSchoolDay}_j) \\ & + \gamma_{03}(\text{Age}_j) + \gamma_{04}(\text{Gender}_j) + \gamma_{05}(\text{Disadvantage}_j) \\ & + \gamma_{06}(\text{Black}_j) + \gamma_{07}(\text{Hispanic}_j) + \gamma_{08}(\text{Other}_j) + \upsilon_{0j}\end{aligned}$$

The binary nature of daily conduct problem symptoms was modeled using multilevel logistic regression and did not include a level 1 residual term.

**Q4.—**Finally, we explored potential next-day associations using autoregressive cross-lagged analyses using person-mean centered variables for level 1 predictors. First, we regressed daily offline parent-adolescent interactions and parent-adolescent digital exchanges on Day X on offline parent-adolescent interactions and parent-adolescent digital exchanges on Day X-1 (a lag of 1 day; alongside the same-day school attendance covariate). Next, we examined similar cross-lagged models for daily mental health and parent-adolescent digital exchanges.

Analyses were conducted in Mplus 7.2 (Muthén & Muthén, 2017) with FIML estimation to handle missing data at both the daily (level 1) and the person level (level 2), and MLR estimation to account for non-normality. Given the large number of comparisons necessary

to test 5 types parent-adolescent digital exchanges predicting parent hassles/uplifts and 4 dimensions of mental health, the Benjamini Hochberg procedure for adjusted significance tests was utilized to manage the False Discovery Rate (FDR; Benjamini and Hochberg, 1995). Descriptive statistics for all study variables are reported in Supplemental Table 1.

## Results

### Q1: How frequently is digital communication used in parent-adolescent exchanges, and which adolescents engage in these parent-adolescent digital exchanges most?

In the EMA subsample (N=388 adolescents, assessed over 5270 combined days), we examined the frequency of parent-adolescent texts/calls (engagement) and the extent to which adolescents reported that they and their parents used the texts/calls for behavioral control (parental solicitation, child disclosure, and parental control) and support seeking (see Table 1). On average, adolescents reported engaging with parents via text/call on 29% of days (24% never reported engaging with a parent via text/call over the study period). Parent solicitation and disclosure were reported on 19% of days (40–41% never), parent control on 7% of days (63% never), and parent support on 6% of days (68% never).

As seen in Figure S1, the overall frequency of engagement in parent-adolescent digital exchanges ($r$=.105, $p$=.040) as well as digital exchanges for support ($r$=.178, $p$<.001) and control ($r$=.203, $p$<.001) tended to increase with age. Females had higher parent digital engagement than males (34% of days for females, 24% of days for males; $F(1) = 12.73$, $p$<.001), as well as more frequent digital solicitation and disclosure (23–24% of days for females and 14–15% of days for males). There was also some variability by race/ethnicity with significant differences for parental control by text/call ($F(3)=4.38$, $p$=.005) and support ($F(3)=3.03$, $p$=.030) such that Black adolescents reported the highest levels of control by text/call (13% of days) and support (10% of days). Parent-adolescent digital exchanges did not, by and large, vary based on economic disadvantage, with the exception of adolescents from more economically disadvantaged families reporting more frequent use of digital communication devices by their parents for control (economically disadvantaged families use texts/calls for control on an average of 9% of days compared to 6% of days among non-disadvantaged families; $F(1)=4.63$, $p$=.032).

### Q2a: Do adolescents report more positive offline parent-adolescent interactions on days when they report parent-adolescent digital exchanges?

Results (Table 1) demonstrate robust daily linkages ($\beta_1$) between four of five daily parent-adolescent digital exchanges and same-day offline parent uplifts; days on which adolescents reported parent digital engagement, support seeking, solicitation, and disclosure were more likely to be days on which they also endorsed the occurrence of a positive experience with their parent offline ($\beta$=.058 to .105); results held over and above the effect of average levels of parent-adolescent digital exchanges, and all four associations remain significant once false discovery rates were accounted for[1]. Only parent digital engagement (reflecting any text/call contact*)* was associated with higher daily offline parent hassles (OR=1.506). This association retained statistical significance after false discovery was accounted for.

**Q2b: Do adolescents who report more frequent parent-adolescent digital exchanges report more positive offline parent-adolescent interactions over the two-week EMA study period?**

As shown in Table 1, adolescents who reported higher average levels of support seeking and parent control via text/call also reported higher average levels of offline parent hassles (even after accounting for false discovery rates). For each percentage point increase in the percent of days on which adolescent reported parental support seeking by text/call over the study period, there was a corresponding 2.8% increase in the average odds that they will experience a parent hassle on any given day. Likewise, each percentage point increase in the percent of days on which adolescents reported parental control by text/call was associated with a 1.9% increase in the average odds of experiencing a parent hassle on any given day. No person-level relations ($\gamma_{01}$) were observed between average levels of offline parent uplifts and parent-adolescent digital exchanges across the EMA study (over and above the daily associations observed in Q2a)[2].

**Q3a: Do adolescents experience fewer mental health problems on days when they report parent-adolescent digital exchanges?**

Tests for daily linkages ($\beta_1$; Table 2) revealed that days on which adolescents reported any of the five parent-adolescent digital exchanges were more likely to be days when they reported relatively more symptoms of inattention/hyperactivity (β= .041 to .083; with associations meeting FDR-corrected significance tests for engagement, solicitation, and disclosure).[3] Similarly, days on which four types of daily parent-adolescent digital exchanges (engagement, support seeking, solicitation, and control) occurred were more likely to be days on which adolescents reported a conduct problem (OR 1.542 to 2.094; with associations meeting FDR-corrected significance tests for engagement, support seeking, and control).

**Q3b: Do adolescents who report more frequent parent-adolescent digital exchanges experience fewer mental health symptoms over the two-week EMA study period?**

Results at the person-level ($\gamma_{01}$; Table 2), revealed that adolescents who reported experiencing the most mental health symptoms, on average across the EMA study, engaged in more parental support seeking via text/call (all associations met FDR-corrected significance), with each additional average percentage point increase in the percent of days on which digital support seeking was endorsed associated with 3.4% higher odds of experiencing a conduct problem on any given day. A 1 standard deviation increase in percent of days when digital support seeking was reported over the two week study period was

[1]Initially, we attempted to model daily parent uplifts and inattention/hyperactivity symptoms as counts with Poisson distributions, but models failed to converge due to the computational burden of simultaneous numerical integration to adjust the distribution of our dependent variable while also fitting the models using FIML to adjust for missing data on both level 1 and 2. We now model parent uplifts and inattention/hyperactivity in linear models (which allow us to use all available data with FIML on both level 1 and level 2) with MLR-adjusted standard errors to account for non-normality. Results from Q2a linear models of parent uplifts are largely consistent with Poisson models (with listwise deletion at level 1; N=381 over 4290 days), with one exception: in the Poisson model daily parent-adolescent digital control was also associated with more same-day parent uplifts (*IRR*=1.14, *p*=.012)

[2]Results from the Q2b Poisson models of count parent uplifts were consistent with these linear model results: no association met FDR-corrected significance, though one association was significant at traditional p<.05: higher average levels of offline parent uplifts were associated with higher average levels of digital support seeking across the EMA study.

[3]Results from the Q3a Poisson models of count symptoms of inattention/hyperactivity were partially consistent, with two daily associations failing to meet traditional significant of p<.05 (Support Seeking IRR=1.066, *p*=.242; Control IRR=1.062, *p*=.258)

associated with 18% of a standard deviation increase in inattention/hyperactivity, 17.5% of a standard deviation increase in average depressive symptoms and 20.6% of a standard deviation increase in worry.

Adolescents who reported higher average conduct problems and inattention/hyperactivity also experienced higher levels of parent control via text/call, with each average percentage point increase in the percent of days on which parent digital control was endorsed associated with a 3.1% increase in the odds of reporting a conduct problem; a 1 standard deviation increase in percent of days when adolescents reported parent control by text/call over the two week study period was associated with 19% of a standard deviation increase in inattention/hyperactivity (both associations met FDR-corrected significance). Adolescents who reported more frequent digital engagement with parents also reported more symptoms of inattention/hyperactivity across the EMA study (though this association did not maintain significance after FDR-correction) [4]; a 1 standard deviation increase in percent of days with parent-adolescent digital engagement was associated with 11.6% of a standard deviation increase in inattention/hyperactivity.

### Exploratory Q4. Do the associations tested in Q3 and Q4 persist to the next day?

As shown in Supplementary Table S2, there were no next-day associations between any domain of parent-adolescent digital exchanges and offline parent hassles. For parent uplifts, however, two next-day associations emerged: Day X-1 digital engagement ($\beta$=.038, $p$=.019) and digital solicitation ($\beta$=.034, $p$=.039) were associated with a higher number of reported parent uplifts on Day X (though neither association remained significant once false discovery was accounted for). Three next-day associations emerged among parent-adolescent digital exchanges and offline mental health (Table S3); adolescents who sought more digital support on Day X-1 tended to report fewer next-day symptoms of inattention/hyperactivity ($\beta$=−.051, $p$=.020) and worry ($\beta$=−.037, $p$=.036) but a higher likelihood of a next-day conduct problem ($\beta$=.079, $p$=.020). None of these three associations met FDR-corrected significance tests.

### Sensitivity Analysis

One strength of our study is that we include all eligible adolescents in our sample, and have not excluded adolescents who do not own their own phones, as we imagine that some may still be in electronic contact with their parents via various means (e.g. home phones, tablets, other devices equipped with text and call functionality). To understand the potential impact of including non-phone owning adolescents in our sample, we conducted a sensitivity analysis which examined the primary study questions in the sample of adolescents who owned their own phones (N=294). As seen in the supplemental materials, results in this subsample were largely consistent with results in the full sample.

[4]Results from the Q3b Poisson models of count symptoms of inattention/hyperactivity were consistent with results from linear models (though the engagement-inattention/hyperactivity link met FDR-corrected significance in Poisson models but not linear models).

## Discussion

This study examined how parents and adolescent children use digital communication in parent-adolescent exchanges and whether these uses are associated with the quality of parent-adolescent offline interactions and adolescents' mental health. Overall, we did not find that parent-child digital exchanges were universally promotive nor universally risky. On the one hand, digital contact appears beneficial: We found that more frequent daily parent-adolescent digital exchanges of several types were linked with more positive same-day interactions, and that parents and adolescents appeared to use digital communication devices as a means for connection, with parents being more likely to "check in" on young people experiencing more behavioral problems and for adolescents who were struggling to seek out parental support. On the other hand, we saw some evidence that those adolescents with more parent digital support seeking and control also reported more offline parent hassles, and that most types of parent-adolescent digital exchanges were linked (at either the daily or person level) with adolescent externalizing problems.

When we examined adolescents' daily reports of their virtual communication with parents, we observed that parents and children communicate less via text/call than we would have anticipated, with the average young adolescent reporting parent digital contact on only 29% of days (26% of days among younger adolescents, and 33% of among older adolescents ages 14+). We observed that females were more digitally engaged with their parents than males, and that females likewise engaged in more parent digital exchanges around solicitation and disclosure. Notably, boys and girls in this sample do not differ on their overall daily use of technology for general text messaging and communication nor time spent on digital technology for school work, entertainment or creating content (Jensen et al., 2019); this gender difference seems to be specific to parent-adolescent digital exchanges, rather than due to overall differences in digital device use. Among adolescents with mobile phones, Black and Hispanic adolescents were the most likely to be in digital contact with their parents. Black adolescents also reported more frequent parent behavioral control and support via text/call than other teens. Youth from economically disadvantaged families were also more likely to have parent digital exchanges which involved control. These findings are consistent with overall patterns of technology use in this sample, where adolescents from economically disadvantaged and Black families reported the highest levels of daily screen time (Jensen et al., 2019), and also consistent with recent statistics on increased prevalence of control-related behaviors among Black and Hispanic parents compared to White parents (Parker et al. 2015). Further, digital communication may be one solution to the practical reality of some parents working long or variable work schedules and needing to use mobile devises to check in when apart from their early adolescent children. Notably, the early adolescents in this sample report engaging digitally with parents less than has been reported in past literature, where 42% of parents retrospectively reported at least daily cell phone contact (Kennedy et al., 2008), nearly 40% of European and Japanese phone-owning children reported daily messaging with parents (DOCOMO 2014) and adolescent phone owners aged 13 to 19 reported 1.99 calls to and 2.43 calls from mobile phone owning parents per day (Weisskirch 2009). These lower estimates of digital engagement frequency may be due in part to data collection methods; other studies have utilized retrospective self

and parent report, which may be subject to recall bias, whereas the present study utilizes daily assessments and may provide a more accurate, time-anchored estimates. Furthermore, our study differs from others (Weisskirch 2009; DOCOMO 2014) in that we did not exclude adolescents who were not yet phone owners (72% owned their own phones at the EMA survey; these phone owners reported any parent digital contact on 33% of days); our current estimates of time usage are thus realistic averages of parent digital contact in a population representative sample of younger adolescents who do and do not own their own phones.

Despite lower-than-expected frequencies (and consistent with our hypothesis) daily parent-adolescent digital exchanges were rather consistently associated with parent uplifts; adolescents had considerably higher odds of experiencing a parent uplift on days when their parents called or texted for any reason except control. This suggests that days when things are going well with parents also tend to be days when children text or call more with their parents. Daily digital exchanges were not as consistently linked with parent hassles. The one exception to this pattern was that more parent digital engagement was associated with a higher likelihood of experiencing a same-day parent hassle (a finding opposite what we would have predicted). We also observed that those adolescents who generally reported more parent hassles tended to seek more support and experienced more parental control by text/call over the two week-study period. These results (alongside the multiple associations with parent uplifts) may reflect that more parent contact, for any reason, provides more opportunities to experience both positive and negative parent-adolescent interactions. Examination of next-day lagged associations suggested that few of these associations carry over to the next day, though those few that did emerge suggested that parent-adolescent digital exchanges may be preceding uplifting offline parent interactions.

Contrary to our hypothesis (that parent-adolescent digital exchanges would promote adolescent mental health), we saw daily linkages between use of text/calls as a tool in parent-adolescent exchanges and increased rates of externalizing problems (inattention/hyperactivity symptoms and conduct problems), but not consistently with internalizing problems of depression and worry. It is possible that parental digital contact serves as a distraction or is perceived as intrusive, which would be consistent with research suggesting that smartphone notifications increase endorsement of inattention and hyperactivity symptoms (Kushlev et al. 2016). It is not hard to imagine a scenario where frequent buzzing of notifications of parent text messages might prompt endorsement of an item like “I’m having a hard time concentrating or focusing”. However, it is also possible that days on which a youth is more distracted, inattentive, or is getting into trouble also tend to be days on which he or she is also more likely to pick up the phone and interact with a parent in these ways. As our examination of next-day associations yielded little clarity around direction of effects future research ought to leverage experimental and within-day lagged designs to better parse the nature of these findings.

We also saw consistent associations between average support seeking and more symptoms across four domains of mental health. It is important to note that support was the least frequent type of parent-adolescent digital exchange (only 32% of study adolescents reported seeking support by text/call over the study period). This suggests that, though many adolescents are not seeking digital parent support, those who are may be those with the

*highest needs* (i.e. higher average levels of mental health symptoms). Similarly, those adolescents who experienced more externalizing symptoms over the study period reported the most parent control via text/call; again, those adolescents who most need behavioral control may receive it digitally from their parents.

## Conclusion

The present study used thousands of daily observations collected via adolescents' mobile phones to better understand how adolescents and their parents interact digitally in daily life. We saw evidence that parent-adolescent digital contact was associated with more uplifting parent-adolescent interactions, with some evidence that adolescents with the most mental health needs may be seeking and receiving support via calls and texts. These conclusions underscore the importance of understanding *how* adolescents (and their families) use technology, and the function of these tools in adolescents' daily experience.

This study is strengthened by its diverse sample and its use of in-the-moment EMA to yield daily estimates of parent-adolescent digital contact, parent hassles/uplifts, and mental health symptoms, which is usually less subject to the biases inherent to retrospective self-report. Nonetheless, several study limitations merit consideration. First, only adolescent report of digital parent-adolescent exchanges was examined, with no information about the daily occurrence of face-to-face warmth or behavioral control nor parent perspectives on these exchanges. Parent-adolescent digital exchanges and in-person parenting behaviors overlap substantially (Rudi and Dworkin 2018) and future EMA research is required to assess their daily effects, interplay, and how parents perceive these often nuanced exchanges. Second, although we learned much here about parent-adolescent online exchanges and offline interactions, we are not able to parse whether fathers or mothers may be more or less likely to engage with adolescents in these ways, nor whether parent gender may condition the nature of the associations observed. Future research should examine parent gender as a potential moderator, as well as potential interactions with other demographic dimensions like race/ethnicity or socioeconomic status. Third, a number of our daily indicators were infrequently endorsed, which limits the effective sample size and power to detect daily associations. For example, those adolescents who never endorse a given parenting behavior (i.e. the 68% of adolescents who never receive digital parent support) do not contribute to the daily portion of the models but are included in the person-level associations.

Mobile technologies are increasingly integrated into family life. Parent-adolescent digital communications, particularly text messages, are unique in that they leave behind digital traces of naturalistic interactions, which we have long struggled to accurately capture via self-report or observation. Future research ought to harness the wealth of information contained within the content of digital communications to understand parent-adolescent interactions. These results suggest that some families leverage technologies in ways that promote connection, support, and do not seem to detract substantially from the quality of the parent-adolescent relationship. Future research ought to consider how families can best integrate mobile devices as additional resources to support parenting and remain connected – online and offline - during early adolescence, and how family-focused intervention/ prevention efforts can promote these benefits.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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**Table 1**

Multilevel Models of Daily Associations between Parent-Adolescent Digital Exchanges and Offline Parent-Adolescent Interactions (5270 days, N=388)

| | **Offline Parent-Adolescent Interactions** | | | | | |
|---|---|---|---|---|---|---|
| | **Parents Hassles** | | | **Parent Uplifts** | | |
| | ***b* (SE)** | ***OR*** | ***p*** | ***b* (SE)** | ***β*** | ***p*** |
| Engagement | | | | | | |
| Daily $\beta_1$ | **.41 (.13)*** | **1.51** | **.002** | **.27(.05)*** | **.11** | **<.001** |
| Person-mean slope $\gamma 01$ | .11 (.37) | 1.11 | .771 | .06(.21) | .02 | .772 |
| Support Seeking | | | | | | |
| Daily $\beta_1$ | .39 (.24) | 1.47 | .108 | **.35 (.10)*** | **.07** | **<.001** |
| Person-mean slope $\gamma 01$ | **2.79 (.64)*** | **16.21** | **<.001** | .61 (.49) | .07 | .209 |
| Solicitation | | | | | | |
| Daily $\beta_1$ | .24 (.15) | 2.14 | .107 | **.17 (.06)*** | **.06** | **.005** |
| Person-mean slope $\gamma 01$ | −.50 (.43) | .61 | .250 | .30 (.24) | .07 | .208 |
| Disclosure | | | | | | |
| Daily $\beta_1$ | .24 (.15) | 1.27 | .114 | **.27 (.06)*** | **.09** | **<.001** |
| Person-mean slope $\gamma 01$ | −.42 (.42) | .66 | .316 | .24 (.25) | .06 | .346 |
| Control | | | | | | |
| Daily $\beta_1$ | .39 (.21) | 1.47 | .060 | .17 (.09) | .04 | .059 |
| Person-mean slope $\gamma 01$ | **1.91 (.71)*** | **6.73** | **.007** | .13 (.34) | .02 | .714 |

Associations between each type of parent-adolescent digital exchange and each offline parent-adolescent interaction domain are tested in separate multilevel models alongside covariates of daily school attendance and person-level mean school attendance, age, gender, economic disadvantage, and dummy coded race/ethnicity.

Significant relations (p<.05) bolded *indicates coefficients which met FDR-corrected significance level. Raw regression coefficients (b) and standard errors (SE) reported alongside Odds Ratios (OR) and standardized regression coefficients (β).

Parent hassles are modeled as a binary variable (any/none) and parent uplifts are modeled as a continuous variable with FIML to handle missingness on level 1 and level 2 (5270 days, N=388)

**Table 2**

Multilevel Models of Daily Associations between Parent-Adolescent Digital Exchanges and Mental Health

| | **Offline Parent-Adolescent Interactions** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Conduct** | | | **Inattention/Hyperactivity** | | | **Depression** | | | **Worry** | | |
| | ***b* (SE)** | ***OR*** | ***p*** | ***b* (SE)** | ***β*** | ***p*** | ***b* (SE)** | ***β*** | ***p*** | ***b* (SE)** | ***β*** | ***p*** |
| Engagement | | | | | | | | | | | | |
| Daily β1 | **.48 (.18)*** | **1.62** | **.007** | **.12 (.03)*** | **.08** | **<.001** | −.52 (.47) | −.02 | .270 | .57 (.70) | .02 | .411 |
| Person-m slope $\gamma_{01}$ | .81 (.52) | 2.24 | .116 | **.33 (.16)** | **.12** | **.040** | 3.71 (2.15) | .09 | .084 | 5.18 (2.92) | .09 | .077 |
| Support Seeking | | | | | | | | | | | | |
| Daily β1 | **.65 (.25)*** | **1.91** | **.010** | **.13 (.06)** | **.04** | **.022** | −.51 (.81) | −.01 | .524 | 1.71 (1.28) | .02 | .180 |
| Person-m slope $\gamma_{01}$ | **3.40 (1.00)*** | **29.93** | **.001** | **1.20 (.34)*** | **.18** | **<.001** | **16.71 (4.91)*** | **.18** | **.001** | **26.65 (6.26)*** | **.21** | **<.001** |
| Solicitation | | | | | | | | | | | | |
| Daily β1 | **.43 (.18)** | **1.54** | **.019** | **.15 (.04)*** | **.08** | **<.001** | .09 (.59) | .<.01 | .880 | .45 (.88) | .01 | .612 |
| Person-m slope $\gamma_{01}$ | −.21 (.60) | .81 | .729 | .06 (.18) | .02 | .750 | .98 (2.35) | .02 | .677 | .24 (3.29) | <.01 | .941 |
| Disclosure | | | | | | | | | | | | |
| Daily β1 | .36 (.20) | 1.43 | .077 | **.13 (.04)*** | **.07** | **.001** | −.99 (.55) | −.04 | .072 | −.04 (.81) | >−.01 | .963 |
| Person-m slope $\gamma_{01}$ | .04 (.58) | 1.04 | .951 | .15 (.18) | .05 | .397 | 1.68 (2.31) | .04 | .467 | 2.24 (3.23) | .04 | .489 |
| Control | **.74 (.27)*** | **2.09** | **.006** | **.13 (.06)** | **.05** | **.025** | −.62 (.90) | −.02 | .494 | 1.68 (1.41) | .03 | .233 |
| Daily β1 | | | | | | | | | | | | |
| Person-m slope $\gamma_{01}$ | **3.15 (.91)*** | **23.24** | **.001** | **1.04 (.32)*** | **.19** | **.002** | 7.59 (5.01) | .10 | .130 | 9.42 (5.77) | .09 | .103 |

Associations between each type of parent-adolescent digital exchange each mental health domain are tested in separate multilevel models alongside covariates of daily school attendance and person-level mean school attendance, age, gender, economic disadvantage, and dummy coded race/ethnicity. Significant relations bolded

* indicates coefficients which met FDR-corrected significance level. Raw regression coefficients (standard errors) reported

*OR* Odds Ratio, *β* standardized regression coefficient. All models employ FIML to handle missingness on level 1 and level 2 (5270 days, N=388)