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Triadic relations between parents' screen use, parenting stress and child vocabulary ability

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Abstract

The present study aimed to primarily investigate the role of parental mobile phone use in predicting children's receptive and expressive vocabulary ability. A secondary aim was to investigate the triadic relations between parents' mobile phone use, parenting stress and children's receptive and expressive vocabulary ability. Parents' iPhone screen time data were automatically recorded for seven consecutive days, whilst parents self-reported the hours in which they were in the presence of their child during those seven days. Successively after the collection of these data, twenty parents and their 36-month-old children came into the Plymouth BabyLab whereby parenting stress and child vocabulary ability were controllably measured. The amount of time parents spent on their mobile phone in the presence of their child interacted with the effect of socioeconomic status to negatively predict children's receptive, but not expressive, vocabulary ability. Parenting stress also negatively predicted children's receptive, but not expressive, vocabulary ability, and did so independently of the effect of SES. Parenting stress did not, however, predict the amount of time parents spent on their mobile phone whilst in the presence of their child. It was concluded that (1) children's expressive vocabulary may be less susceptible to the effects of parental mobile phone use than children's receptive vocabulary, (2) parenting stress is not a short-term predictor of parents' mobile phone use, and (3) children's expressive vocabulary may also be less susceptible to the effects of parenting stress than children's receptive vocabulary. Directions for future research are discussed.

Keywords: triadic relationships, mobile phone use, screen use, parenting stress, child vocabulary ability, child expressive vocabulary, child receptive vocabulary, WinG test, SES, Plymouth BabyLab, psychology

Introduction

“*Technoference*” is a novel expression that has been coined to emphasise the everyday interruptions that occur in instances of digital and mobile technology use during interpersonal interactions (McDaniel, 2015). Of particular interest in recent research are the implications of technoference during parent-child interactions, in which it has been consistently demonstrated that excessive parental mobile phone use is associated with suboptimal parent-child interactions (Kildare & Middlemiss, 2017). The extent to which technoference during parent-child interactions may be a common issue amongst many families was highlighted in a recent survey involving two-thousand parents of school-aged children, in which it was reported that 62% of parents admitted to spending too much time on their mobile phone in the presence of their children (OnePoll, 2019). Given the finding that infants’ word learning occurs in the nexus of social interaction (Tamis-LeMonda, Kuchirko & Song, 2014), in conjunction with the significance of early childhood language ability in predicting later school readiness and success (Hoff, 2013), technoference during developmentally important parent-child interactions may pose particularly detrimental implications for language-learning infants. It therefore seems crucial to develop a well-informed understanding of the implications parental mobile phone use may have on language-learning infants. Very few studies have examined such implications and in doing so have often relied upon self-report mobile phone use data which may be an unreliable measure of parents’ unpretentious screen use (Boase & Ling, 2013).

As a further matter, given that parents are acknowledging their own screen use as “too much” (OnePoll, 2019), what is of importance to discover are parents’ incentives for such consciously undesired amounts of screen use. Research investigating parents’ perceptions of their own screen use identified one incentive as a desired escape from the stress and boredom of raising a child (Radesky et al., 2016), thus undesired amounts of screen use may in fact be a coping strategy used by parents in response to the stresses associated with parenting. The succeeding sections begin with a discussion of research establishing the role of parental lexical input in promoting children’s vocabulary development, followed by an exploration of how parents’ screen use has the potential to disrupt the lexical input parents provide their children, and subsequently a discussion of research establishing the relations between parenting stress and parents’ mobile phone use.

Parent input and child vocabulary

One robust foundation of variability in language learning amongst children is a disparity in access to language from caregivers. A longitudinal study by Hart and Risley (1992) recorded naturalistic observations of parent-child interactions beginning when the child was aged between 7- and 12-months, up to the age of 36-months. Upon later analysis of these data, Hart and Risley (2003) revealed that the amount of language and interaction children were exposed to from their caregivers during infancy positively predicted their vocabulary growth rate and subsequent vocabulary size at 36-months. Moreover, the amount of language and interaction children were exposed to was strongly and positively associated with socioeconomic status (SES). The magnitude of these SES-related differences in children’s language exposure was demonstrated through extrapolation of data, in which it was shown that by age four, a child from a low-SES family would have accumulated experience with thirty million less words than a child from a high-SES family. In a follow-up study, Walker, Greenwood, Hart and Carta (1994) demonstrated that the differences

observed in children's vocabulary at 36-months persisted in predicting their subsequent language accomplishments and academic achievements at the age of 9- to 10-years. Together this research highlights the critical importance of the quantity of parental lexical input during infancy, not only for optimal vocabulary development in early childhood but also for vocabulary ability and academic achievement in later childhood.

Not only is the quantity of parental lexical input important for children's vocabulary development, but also the quality of that input. Through naturalistic observations of parent-child interactions at two time points ten weeks apart, Hoff (2003) found that two-year-old infants' productive vocabulary was positively predicted ten weeks later not only by the quantity of parental lexical input, but also by the number of different words the parent addressed to the infant, as well as the mean length of the parents' child-directed utterances. Moreover, Hoff (2003) demonstrated that the negative association between SES and children's vocabulary was in fact mediated by these properties of parental speech. Parents are evidently a very important source of lexical input for infants' evolving language, with research emphasising both the quantity and quality of speech as being particularly important properties of that lexical input (Hart & Risley, 2003; Hoff, 2003). In light of these findings, if the suboptimal parent-child interactions that are associated with parental mobile phone use (Kildare & Middlemiss, 2017) involve reduced parental lexical input which is of poor quality, then one would anticipate parents' screen use to negatively influence a child's vocabulary.

Parents' screen use and child vocabulary

As the popularity of mobile phone technology has grown rapidly over recent years, initial research examining the implications of technoferece during parent-child interactions did so with the use of television (T.V.) media. Observational data of parent-child interactions revealed that in the presence of background T.V., and regardless of whether the child was 12-, 24- or 36-months-old, parents exhibited less verbal behaviour and spent more time not interacting with their child at all than in the absence of background T.V. (Kirkorian, Pempek, Murphy, Schmidt & Anderson, 2009). Upon secondary analysis of these data to compare both the quantity and quality of parental lexical input in the presence and absence of background T.V., it was found that in its presence, both the number and diversity of words spoken by the parent per minute decreased when compared to that spoken in its absence (Pempek, Kirkorian & Anderson, 2014). In light of the findings that both the quantity and quality of parental lexical input is predictive of infants' subsequent vocabulary ability (e.g. Hoff, 2003), chronic exposure to background T.V. may have deleterious effects on infants' vocabulary development. Given that mobile phone technology provides a portable and accessible means of communication and internet connection, emphasising a much higher demand for parents' attentional resources than that of background T.V., one would anticipate such effects to be exacerbated as a consequence of parental mobile phone use.

Observations of parental mobile phone use at mealtimes provide an opportunity to examine the implications of technoferece during parent-child interactions in a common routine that families engage in day-to-day. Naturalistic observational data of parents eating with their school-aged children in fast-food restaurants revealed that 30% of parents were completely absorbed with their mobile phone, neglecting

interaction with their child (Radesky et al., 2014). To supplement this qualitative research, Radesky et al. (2015) quantitatively examined associations between parental screen use and parent-child interactions and found that parents who used their mobile phone spontaneously during a structured eating task engaged in fewer verbal interactions with their child than parents who did not use their mobile phone or did so negligibly. These parents also initiated fewer verbal and non-verbal encouragements when their child was presented with an unfamiliar food. Mealtimes represent one context in which there are diverse opportunities for word-learning to occur, for example, that of novel foods. If parents are engaged in their screens in such a context, neglecting the opportunity for developmentally important verbal interaction and encouragement with their child, then over time this accumulated lack of lexical input is likely to have negative implications for a child's vocabulary development (Hart & Risley, 2003; Hoff, 2003).

Whilst prior research has considered the effects of spontaneous parental screen use on the nature of parent-child interactions, more recent research has begun to manipulate parents' screen use to directly explore its effects on infants' ability to learn novel words. Reed, Hirsh-Pasek and Golinkoff (2017) manipulated parents' screen use in a structured word-learning task to examine its subsequent effect on two-year-old infants' learning of novel verbs. Mothers taught their infants two novel verbs across two separate teaching phases: in one phase mothers were interrupted with a short phone call and in another there was no such interruption. Despite the total amount of teaching time being the same in each teaching phase, infants only successfully learned novel verbs when teaching was uninterrupted. This supplements previous research by demonstrating how parents' screen use can directly hinder word-learning, and not just the nature of parent-child interactions.

Given the reviewed literature establishing the importance of parental lexical input in promoting children's vocabulary development (Hart & Risley, 2003; Hoff, 2003), if a large portion of a parents time with their child is spent engaged in their mobile phone, and if these parent-child interactions involve reduced lexical input which is of poorer quality than interactions in the absence of their mobile phone, then one would expect children of those parents to have poorer vocabulary abilities than children of parents with less substantial mobile phone habits. Preliminary research conducted by Floccia and Hanoch (2018) has indeed established such a negative association, demonstrating that the more time parents spent on their mobile phone in the presence of their child, the poorer their child's expressive and receptive vocabulary abilities. There are however notable limitations to this research, including the use of self-report screen use data as well as the use of vocabulary measures that rely on parental judgement, thus further research is needed to demonstrate consistency in these findings whilst controlling for such limitations.

Parenting stress and parents' screen use

Given that in a state of technoference, the verbal interactions between a parent and child are of both reduced quantity and quality (e.g. Pempek et al., 2014), what remains of interest in research are parents' incentives for engaging in their mobile phone at the expense of interacting with their child. Radesky et al. (2016) conducted semi-structured interviews with parents of children aged between 0- and 8-years regarding their mobile device use and its relationship with family interactions. Many parents highlighted the stress-reducing nature of their device use, describing its use

as a desired escape from the stress or boredom of raising a child, whilst others described its use as stress-inducing, thus revealing contrasting insights into parents' subjective perceptions of their own screen use. Given, however, that parents identified the source of their stress as being exclusively related to child-rearing, in light of the fact that parenting stress is a multifactorial concept which involves the parent, the child and the context within which parent-child interactions occur, and which relates to stress that is exclusively derived from the role of parenting (Abidin, 1995), these findings highlight the relevance of parenting stress as a potential incentive for parental mobile phone use. What remains unestablished from this research, however, is whether a true association between parenting stress and parents' device use exists. A longitudinal study by McDaniel and Radesky (2018) revealed that parenting stress positively predicted parents' mobile phone use both one month, and two months later. Such findings elaborate upon those of Radesky et al. (2016) by demonstrating that there is indeed a true, positive relationship between parenting stress and parents' mobile phone use. Additional observational data of spontaneous parental mobile phone use during both family mealtimes in the home and in a structured laboratory eating task found that parents' screen use in both contexts was positively associated with parents' mental representations of how challenging they perceived their child to be (Radesky et al., 2018). Given that child difficulty is a constituent of parenting stress (Abidin, 1995), these findings again highlight a positive association between parenting stress (particularly that derived from child difficulty) and parents' mobile phone use, thus supporting those findings of McDaniel and Radesky (2018).

When considering the positive association between parenting stress and parents' device use in light of the established negative association between parents' device use and children's vocabulary ability, it is rational to theorise that parenting stress may also be indirectly negatively associated with child vocabulary ability. Noel, Peterson and Jesso (2008) established such an association, demonstrating that higher levels of parenting stress were associated with poorer expressive and receptive vocabulary ability in preschool infants. It is then rational to postulate that this negative association could be mediated by parents' mobile phone use.

The present study aimed to elaborate upon the preliminary research of Floccia and Hanoch (2018) whilst controlling for a number of its limitations, primarily investigating the relationship between parents' mobile phone use and 36-month-old infants' vocabulary ability whilst controlling for the effect of SES. A secondary aim was to investigate the triadic relations between parenting stress, parents' screen use and child vocabulary. It was hypothesised that (1) the amount of time parents spent on their mobile in the presence of their child would negatively predict children's vocabulary ability, (2) parenting stress would positively predict the amount of time parents spent on their mobile phone in the presence of their child, and (3) parenting stress would negatively predict children's vocabulary ability.

Methodology

Participants

Participants who met eligibility criteria, which included infants who were monolingual and aged within fourteen days of 36-months, whose parents' primary mobile device was an iPhone, were identified through the University of Plymouth BabyLab

database and recruited via email. Five mothers and their typically developing, monolingual infants (3 female, 2 male), aged approximately 36-months (precise M and SD are unavailable due to unforeseen circumstances during the COVID-19 pandemic) were successfully tested. The data of three additional participants were rejected due to unsuccessful measures of parents' screen time. Furthermore, having only a limited amount of time to collect data during the COVID-19 pandemic, artificial data were computed for an additional fifteen participants based on the authentic data that was successfully collected. Data were therefore obtained for a total of twenty participants (10 female, 10 male). SES was determined by the highest level of education obtained by the infants' parents. Education level was represented on a numerical scale from 0 to 5, where 0 represented primary-level education and 5 represented postgraduate education. All infants came from comparable mid- to high-SES families ($M = 3.95$, $SD = .94$).

Measures

Child expressive and receptive vocabulary

Children's language comprehension and production abilities were assessed using the Words in Game (WinG) test, a standardised vocabulary assessment tool for children aged between 19- and 36-months (Cattani, Krott, Dennis & Floccia, 2019). The WinG test assesses the lexical comprehension and production of nouns and predicates in infants using four subtests: Noun Comprehension (NC), Predicate Comprehension (PC), Noun Production (NP) and Predicate Production (PP). It uses one-hundred and twenty-six colour-photograph cards (10x13cm), which represent an object (e.g. spoon), or a context which portrays an action (e.g. drinking), a descriptive word (e.g. tall), or a locative word (e.g. behind). Forty-two cards are allocated as targets for the comprehension subtests (NC and PC), another forty-two as targets for the production subtests (NP and PP) and a final forty-two are used as distractors. The WinG test involves a total of forty-four trials, four of which are pre-test trials for training purposes. The NC and NP subtests comprise the first twenty trials (plus two pre-test trials) in which sixty photographs, divided into twenty triplets, are presented. The photographs used in the NC and NP subtests include: familiar objects of everyday use (15); clothing (11); furniture and objects of the house (9); animals (8); places and outside objects (7); food and drink (5); transport (4); and toys (1). The PC and PP subtests comprise the final twenty trials (plus two pre-test trials), in which another sixty photographs divided into twenty triplets are presented. The photographs used in the PC and PP subtests include contexts which either portray actions (36), adjectives (17), or adverbs (7). The WinG test produces four numerical scores, one for each of the four subtests, whereby higher scores indicate more advanced vocabulary abilities.

Parents' knowledge of their child's language comprehension and production abilities was measured using a standardised one-hundred item communicative development inventory (CDI; Floccia et al., 2018). Of the one-hundred items included in the CDI, fifty-six are nouns, thirteen are action words, and thirty-one are other words such as adjectives. The CDI produces two numerical scores, one of which represents parents' judgements of their child's language comprehension ability and another which represents judgements of their child's language production ability, whereby higher scores indicate more advanced vocabulary abilities.

Parents' screen time

Parents' mobile phone use was measured automatically using official iPhone 'screen time' data and was manually recorded by researchers by averaging the amount of screen time per hour, between the hours of 05:00 and 21:00, to the closest fifteen-minutes (i.e. 0, 15, 30, 45, 60). Screen time data were recorded using a screen time log which was developed by researchers with the use of Microsoft Word (see Appendix D). The screen time log consisted of a 19x8 table labelling seven days, divided into sixteen hourly periods between the hours of 05:00 and 21:00.

To measure the hours in which parents used their mobile phone specifically in the presence of their child, a bespoke BabyLab application 'child time' was developed by Technical Support Staff at the University of Plymouth which recorded the hourly time periods parents self-reported they were in the presence of their child for fifteen minutes or more each day (see Appendix E). The application presented a check-box list of a sixteen-hour day, divided into the same hourly periods that were recorded for parents' screen time using a twenty-four-hour clock format. Upon completion of recording, child time data were saved to a Microsoft Excel database which was accessible to researchers. The total amount of time parents used their mobile phone in the presence of their child each day was manually calculated by researchers by comparing parents' hourly screen time each day to the hours in which parents' self-reported they were in the presence of their child on the same day.

Information regarding parents' perceptions of their own mobile phone use was collected using a questionnaire which was originally developed by Plymouth BabyLab researchers and modified by the present researchers for the purposes of the present study (see Appendix F). The two questionnaire items of interest were (1) I use my phone to relieve stress related to parenting, and (2) using my phone makes me feel stressed, each of which items were answered using a five-point Likert scale which ranged from "strongly agree" to "strongly disagree".

Parenting stress

Parenting stress was measured using the Parenting Stress Index- Short Form (3rd Edition, PSI-SF; Abidin 1995), which is a measure of the stress occurring within the parent-child system and regarding the role as a parent. The PSI-SF is a thirty-six-item questionnaire which uses a five-point Likert scale, where 1 represents "strongly agree" and 5 represents "strongly disagree". It measures three factors: stress caused by parental distress (PD), parent-child dysfunctional interaction (P-CDI) and parents' perceptions of how difficult their child is (DC). Collectively, these three sub-scales provide a total stress score (SF), whereby higher SF scores indicate greater levels of parenting stress. PD is associated with stressors such as conflict with the child's other parent and lack of social support. P-CDI is associated with feelings such as an impaired sense of parenting competence, and feelings that interactions with the child are not reinforcing. DC is associated with characteristics of the child that make them either easy or difficult to manage. The PSI-SF was chosen as a concise but psychometrically sound alternative to the full-length PSI, whose correlations with the PSI-SF ranged between 0.87 and 0.94 (Abidin, 1995).

Design

This study utilised a correlational design. To investigate the primary hypothesis, dependent variables (DV) were both children's language comprehension and production of nouns assessed by the WinG test (Cattani et al., 2019). The primary

independent variable (IV) was the amount of time parents spent on their iPhone whilst in the presence of their child, with SES being controlled as a covariate as previous research found SES to be strongly positively associated with child vocabulary size (Hart & Risley, 2003). To investigate the first of the secondary hypotheses, the amount of time parents spent on their iPhone whilst in the presence of their child was the DV, with total parenting stress assessed by the PSI-SF (Abidin, 1995) examined as the IV. To investigate the additional secondary hypothesis, DV's were both children's language comprehension and production of nouns, with total parenting stress examined as the IV, and SES again controlled as a covariate.

Procedure

The present study consisted of two parts: the first was completed outside of the laboratory and involved the recording of both parents' mobile phone use and child time, whilst the second part was completed inside the laboratory and involved the completion of child vocabulary assessments and parent-directed questionnaires. Upon an expression of interest from parents to take part in the present study in response to an email invitation, a date was firstly arranged for participants to come into the Plymouth BabyLab to complete the second part of the study. This was arranged before completion of the first part to ensure that parents' screen time and child time data could be recorded for seven consecutive days preceding the completion of language assessments and parent-directed questionnaires. This ensured that all data collected were representative of the same period of time. Following such arrangement, parents were sent an email which provided them with a URL link to the child time application. Upon activation of this app, parents entered their full name, their child's first name, their mobile number and the date they would commence recording. This date was specified in the email and was precisely eight days prior to the date they had arranged to complete the second part of the study. Demographic information was requested so that participants' data could be accurately identified upon later retrieval, and parents' mobile number was requested so they could be sent an automated daily text message (at a preferred time of their choice) to remind them to record child time for the previous day. The text message read "Child time day (recording day e.g. 1), record time spent with your child yesterday (day, date): (unique participant URL link to BabyLab application)". The URL link provided in the text message activated the child time application in which parents identified the hours, between 05:00 and 21:00, they had spent more than fifteen minutes with their child on the previous day. Child time data were recorded for a maximum of fourteen days to allow for the possibility that participants needed to postpone the second part of the study, and recording stopped if either participants opted-out of the study or submitted their complete data set after being requested to do so by researchers. Following completion of recording for at least seven days, participants submitted their data on the child time application. Screen time data were measured and recorded by iPhone automatically, thus it was not essential for parents to be made aware that researchers would be recording their screen time data during the second part of the study. Moreover, it was important for parents' to be initially unaware of this to ensure that their screen time use was unpretentious and representative of their typical daily mobile phone habits.

Upon arrival at the BabyLab for the second part of the study, participants were greeted by researchers and the parent was presented with both an information sheet (see Appendix A) and a consent form (see Appendix B). If the BabyLab had no

previous record of participants' demographic data then this was verbally collected by the researcher following a written demographic questionnaire. After the parent had given consent for both themselves and their child to participate, the researcher spent some time establishing a relationship with the child before beginning the WinG test, by talking and playing with some toys. After establishing such a relationship, the parent was presented with a mobile phone use questionnaire, a CDI and a PSI-SF, and was asked to complete these during the WinG test. This was done to avoid parental interference during the WinG test. The researcher then led participants into a quiet, soundproof room whereby the child sat at a table, at a 90° angle from the researcher, whilst the parent sat on a chair at the back of the room behind the child. A co-researcher was also present in the corner of the room to start and stop the video recording and to code the WinG test.

After initiating the video-recording, the researcher began the WinG test by administering the two noun subtests (NC and NP) in parallel. In each trial, the researcher placed the triplet of cards in a random landscape row on the table directly in front of the child. The NC subtest was completed first by asking the child to choose the card which corresponded to the noun spoken by the researcher (e.g. "can you show me the mountain"). Following the child's correct or incorrect response, the researcher moved successively onto the NP subtest for that trial by removing the comprehension and distractor cards from the child's view, leaving only the production card visible on the table. The NP subtest was completed by asking the child to name the noun presented in the production card (e.g. "what is it"). If the child correctly named the noun, the researcher removed the production card from the child's view and continued with the next trial. If the child chose incorrectly, however, the researcher gave a second elicitation (e.g. "shall we take a closer look and see what else it could be"). Regardless of whether the child produced the correct or incorrect noun on this second elicitation, the researcher continued to move onto the next trial. The two noun pre-test trials were presented first, and upon successful completion of both the NC and NP subtests for each of the pre-test trials, the researcher administered the following twenty noun test-trials in a sequential order. After completion, the researcher successively moved onto the twenty predicate trials, again presenting the two subtests (PC and PP) in parallel. The predicate trials were completed in an identical manner to the noun trials, firstly presenting the comprehension subtest (PC) by asking the child to choose the card which corresponded to the predicate word spoken by the researcher (e.g. "can you show me which is big"), immediately followed by the production subtest (PP) for that trial, asking the child to produce the predicate word portrayed in the production card (e.g. "what is this like"). As with the noun trials, regardless of whether the initial response given was correct or incorrect on the PC trials, the researcher moved onto the PP subtest for that trial. If the initial response was incorrect on the PP subtest, however, a second elicitation was given by visually comparing the production card to the comprehension card for that trial, which had an opposite meaning (e.g. "if this is big, what is this one like"). This procedure was repeated until all twenty predicate trials were complete.

Upon completion of the WinG test, the co-researcher terminated the video-recording and the researcher led participants out of the booth and back into the waiting area. The researcher then requested consent from the parent to access their recorded iPhone screen time data. If consented by the parent, the researcher manually

recorded the previous seven days of screen time data using the screen time log (see Appendix D). The researcher then provided the parent with a study debrief (see Appendix C) and congratulated the child for their participation, presenting them with a certificate and a small complimentary gift of their choice.

Results

Descriptive statistics for all study variables are presented in Table 1.

Table 1: Mean scores and standard deviations on measures of demographics, child vocabulary, parenting stress and parental screen use.

Measure	<i>M</i>	<i>SD</i>
Demographics		
SES	3.95	0.94
Vocabulary (percentile)		
NP	50.50	25.44
NC	57.50	21.61
CDI understands	87.20	8.41
CDI says	84.15	9.47
Parenting stress (percentile)		
PSI-SF total	55.00	26.16
Parents' screen use (minutes)		
Screen with child	975.95	485.90

In order to examine the validity of parents' judgements of their child's receptive and expressive vocabulary ability, Pearson's correlations were conducted to (1) compare parental judgement of child language comprehension ability on the CDI with child language comprehension scores on the WinG test, and (2) compare parental judgement of child expressive language ability on the CDI with child expressive language scores on the WinG test. Parental judgement of child receptive vocabulary using the CDI was moderately positively correlated with child noun comprehension scores on the WinG test at a statistically significant level, $r = .47$, $p < .05$. Parental judgement of child expressive vocabulary ability using the CDI, however, was non-significantly weakly positively correlated with child expressive vocabulary scores on the WinG test, $r = .29$, $p = .22$.

Relations between parents' screen use and child vocabulary

To test the hypothesis that the amount of time parents spent on their mobile phone whilst in the presence of their child would negatively predict child vocabulary ability, two multiple hierarchical regression analyses were conducted to examine the variance in child expressive and receptive vocabulary that was attributable to parents' screen use in the presence of the child, after controlling for the variance attributable to SES. The first regression analysis tested the prediction of child noun comprehension, and results showed that after controlling for SES, which accounted for a non-significant 16.5% of the variance in child noun comprehension, parents' screen use accounted for an additional, non-significant 14% of its variance (see

Table 2). The overall model including SES and parents' screen use, however, explained a statistically significant 30.5% of the variance in child noun comprehension ($R^2 = .305$, $F(2,17) = 3.74$, $p < .05$). In this model, SES was a positive predictor and parents' screen use a negative predictor, although neither variables were uniquely statistically significant predictors (see Table 2).

Table 2: Multiple hierarchical regression analysis showing SES and parents' screen use in the presence of the child as predictors of child noun comprehension.

Variable	Cumulative		Simultaneous	
	R^2 change	F change	β	p
Step 1				
SES	.165	$F(1,18) = 3.55$.20	.41
Step 2				
Parents' screen with child	.140	$F(1,17) = 3.44$	-.43	.08

Note. All standardised coefficients are from model 2.

The second regression tested the prediction of child noun production, and results showed that after controlling for SES, which accounted for a non-significant 2.1% of the variance in child noun production, parents' screen use accounted for an additional, non-significant 16% of its variance (see Table 3). Collectively, SES and parents' screen use accounted for a non-significant 18.1% of the variance in child noun production ($R^2 = .181$, $F(2,17) = 1.87$, $p = .18$).

Table 3: Multiple hierarchical regression analysis showing SES and parents' screen use in the presence of the child as predictors of child noun production.

Variable	Cumulative		Simultaneous	
	R^2 change	F change	β	p
Step 1				
SES	.021	$F(1,18) = .38$	-.08	.75
Step 2				
Parents' screen with child	.160	$F(1,17) = 3.32$	-.46	.09

Note. All standardised coefficients are from model 2.

The hypothesis that the amount of time parents spent on their mobile phone in the presence of their child would negatively predict child vocabulary ability was therefore only supported for child receptive vocabulary, although it was not supported independently of the effect of SES. Although parents' screen use was not a uniquely statistically significant predictor of child noun comprehension, a statistically significant regression model predicting child noun comprehension was obtained when the effect of parents' screen use was joint with the effect of SES, thus suggesting there were interaction effects between parents' screen use and SES.

Relations between parenting stress and parents' screen use

To test the hypothesis that parenting stress would positively predict the amount of time parents spent on their mobile phone whilst in the presence of their child, a linear regression analysis was conducted. Parenting stress was a non-significant predictor of parents' screen use, explaining a non-significant 1% of its variance ($R^2 = .001$, $F(1,18) = .01$, $p = .92$), thus hypothesis (2) was rejected.

Parents' responses to questionnaire items regarding their beliefs about the nature of their mobile phone use and its relationship to parent-related stress are presented in Figure 1. Over half of parents agreed that they use their mobile phone to reduce stress related to the role of parenting, whilst none agreed that their mobile phone use has stress inducing effects. Rather, the majority of parents were either unsure or disagreed that its use had stress inducing effects.

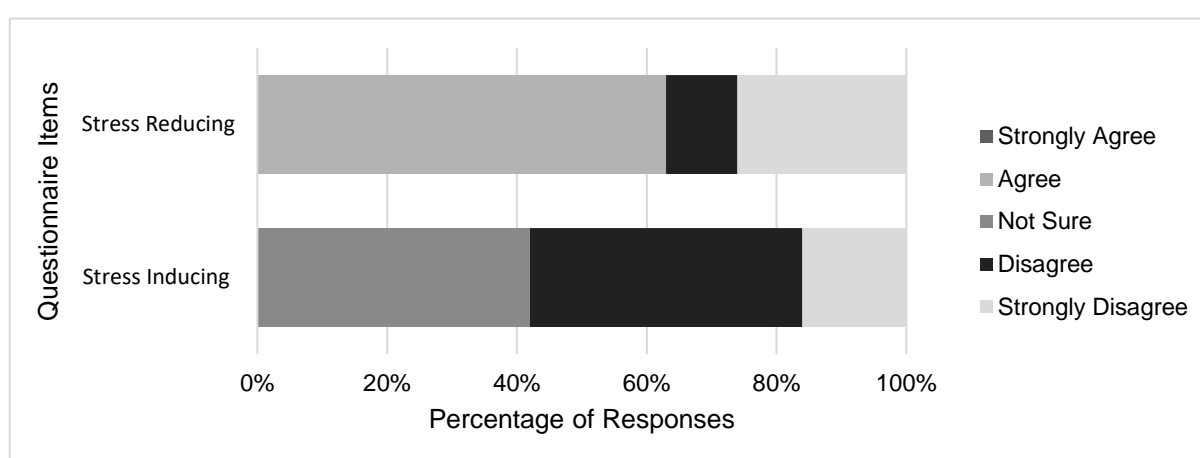


Figure 1: Stacked bar graph showing parents' responses to questionnaire items regarding beliefs about their mobile phone use.

Relations between parenting stress and child vocabulary

To test the hypothesis that parenting stress would negatively predict infants' vocabulary ability, two multiple hierarchical regression analyses were conducted to examine the variance in child expressive and receptive vocabulary that was attributable to parenting stress, after controlling for the variance attributable to SES. The first regression tested the prediction of child noun comprehension and results showed that after controlling for SES, which accounted for a non-significant 16.5% of the variance in child noun comprehension, total parenting stress accounted for an additional, statistically significant 17.8% of its variance (see Table 4). Collectively, SES and total parenting stress accounted for a statistically significant 34.3% of the variance in child noun comprehension ($R^2 = .343$, $F(2,17) = 4.45$, $p < .05$). In this model, SES was a statistically significant positive predictor of child noun comprehension, and parenting stress a statistically significant negative predictor (see Table 4).

Table 4: Multiple hierarchical regression analysis showing SES and total parenting stress as predictors of child noun comprehension.

Variable	Cumulative		Simultaneous	
	R^2 change	F change	β	p

Step 1				
SES	.165	F(1,18) = 3.55	.43	.04
Step 2				
Total	.178	F(1,17) = 4.62*	-.42	.05
Parenting Stress				

Note. * $p < .05$

All standardised coefficients are from model 2

The second regression tested the prediction of child noun production, and results showed that after controlling for SES, which accounted for a non-significant 2% of the variance in child noun production, parenting stress accounted for an additional, non-significant 14.6% of its variance (see Table 5). Collectively, SES and parenting stress accounted for a non-significant 16.6% of the variance in child noun production ($R^2 = .166$, $F(2,17) = 1.70$, $p = .21$). The hypothesis that parenting stress would negatively predict child vocabulary ability was therefore only supported for child receptive, but not expressive, vocabulary.

Table 5: Multiple hierarchical regression analysis showing SES and total parenting stress as predictors of child noun production.

Variable	Cumulative		Simultaneous	
	R ² change	F change	β	p
Step 1				
SES	.02	F(1,18) = .55	.17	.46
Step 2				
Total	.146	F(1,17) = .10	-.38	.10
Parenting Stress				

Note. All standardised coefficients are from model 2.

Results demonstrate that whilst parents' screen use interacted with the effect of SES to negatively predict children's receptive vocabulary, it did not predict children's expressive vocabulary. Comparably, although independently of the effect of SES, parenting stress also negatively predicted children's receptive vocabulary, but did not predict children's expressive vocabulary. Furthermore, parenting stress did not predict parents' screen use.

Discussion

This is the first study to continuously record parents' screen use outside of a specific context, which previous research has been limited to. It is also the first to compare parents' unpretentious screen use to children's vocabulary ability using a standardised child-directed vocabulary assessment tool (Cattani et al., 2019). Using such measures, it was found that parents' screen use interacted with the effect of SES to negatively predict children's receptive, but not expressive, vocabulary ability. The present study also compared parents' total level of parenting stress to the amount of time they spent on their mobile phone in the presence of their child, to investigate whether parenting stress positively predicted parents' screen use. Such comparisons revealed that parenting stress did not predict parents' screen use. Furthermore, to investigate the hypothesis that parenting stress would negatively

predict children's vocabulary ability, parents' total level of parenting stress was also compared to children's receptive and expressive vocabulary ability. Results demonstrated that parenting stress negatively predicted children's receptive, but not expressive, vocabulary ability.

Relations between parents' screen use and child vocabulary

As anticipated by the literature which has consistently demonstrated that in instances of technofence during parent-child interactions, parents engage in fewer and lower quality verbal interactions with their child (e.g. Pempek et al., 2014), parents' screen use did indeed negatively predict children's vocabulary ability, at least in the case of receptive vocabulary, thus supporting the preliminary finding that parents' screen use is negatively associated with children's receptive vocabulary (Floccia & Hanoch, 2018). It is important to note, however, that parents' screen use did not predict children's receptive vocabulary independently of the effect of SES, but rather interacted with the effect of SES. One plausible explanation for this interaction may be that parents living in poverty tend to have diminished social support networks (Evans, Boxhill & Pinkava, 2008), and given that mobile phones provide parents with a source whereby they can access social support (Radesky et al., 2016) through texting or social media for example, it is possible that parents of lower-SES backgrounds use their phones to a greater extent to access social support, and thus the degree to which parents' use their mobile phones may in fact be partly dependent on SES.

In the case of expressive vocabulary, however, the present study not only contrasts with the preliminary findings of Floccia and Hanoch (2018), but also with what would be anticipated by additional prior research. Given that the quantity and quality of parental lexical input is positively associated with children's expressive vocabulary (Hoff, 2003), and that these properties of parental speech are reduced in instances of technofence during parent-child interactions (e.g. Pempek et al., 2014), prior research would anticipate, contrarily to what was found in the present study, a negative association between parents' screen use and children's expressive vocabulary. Given, however, that the present study controlled for a number of limitations acknowledged in Floccia and Hanoch's (2018) research, utilising a laboratory child-directed vocabulary assessment tool (Cattani et al., 2019) as opposed to a parental judgement assessment tool (Floccia et al., 2018), as well as measuring parents' screen time with official iPhone screen time data as opposed to relying on self-report data, it could be argued that the present study produced more accurate findings (e.g. Boase & Ling, 2013), and thus it could be suggested that there is in fact no association between parents' screen use and children's expressive vocabulary. Nevertheless, it remains important to acknowledge the findings of Floccia and Hanoch (2018), particularly given that their research was conducted with a considerably larger sample than the present research, and rather consider why the present study may have obtained partially contrasting results.

Comparisons between the CDI (Floccia et al., 2018), utilised in both the present study and by Floccia and Hanoch (2018), and the WinG test (Cattani et al., 2019), used solely in the present study, revealed that scores on the CDI were only (moderately) positively correlated with scores on the WinG test for receptive, but not expressive, vocabulary. Given that receptive vocabulary scores obtained from the CDI and those obtained from the WinG test were positively correlated, and the

present study replicated the negative relationship between parents' screen use and children's receptive vocabulary, yet expressive vocabulary scores obtained from the CDI and those obtained from the WinG test were not correlated, and the present study failed to replicate the finding that parents' screen use was negatively associated with children's expressive vocabulary, it could be suggested that expressive vocabulary scores obtained from the CDI and those obtained from the WinG test are not as representative as one another as scores obtained for receptive vocabulary, thus the associations found between parents' screen use and children's expressive vocabulary ability may well be dependent on the type of vocabulary assessment tool utilised. In light of these methodological differences which may be somewhat accountable for the partially contrasting results between the present research and that of Floccia and Hanoch (2018), the present study may, rather than discounting the association established by Floccia and Hanoch (2018), in fact shed light on a novel finding in developmental research, that children's expressive vocabulary is less susceptible to the effects of technofence during parent-child interactions than children's receptive vocabulary.

Relations between parenting stress and parents' screen use

Previous research has found parenting stress to be a positive predictor of parents' subsequent mobile phone use (McDaniel & Radesky, 2018), yet the present study found no such association. This is interesting given that more than half of parents agreed that they use their mobile phone to relieve stress related to parenting. What is important to note about the present study in comparison to prior research, however, is that measures of parenting stress and parents' screen use were obtained within the same seven days, whereas prior research has investigated the predictive role of parenting stress longitudinally. The present study may therefore add to current research by demonstrating that parenting stress is not a short-term predictor of parents' screen use, but rather, as demonstrated by McDaniel and Radesky (2018), takes its effect on parents' screen use over a longer period of time. It is possible, for example, that increased parenting stress is initially associated with alternative coping behaviours before parents begin to withdraw from parent-child interactions by spending more time on their mobile phone.

Relations between parenting stress and child vocabulary

The present study elaborates upon the finding that parenting stress is negatively associated with children's receptive vocabulary ability (Noel, Peterson & Jesso, 2008) by demonstrating that parenting stress in fact negatively predicts children's receptive vocabulary, over and above the effect of SES. Whether or not this association is mediated by parents' screen use is unclear, as in contrast to longitudinal research (McDaniel & Radesky, 2018), the present study found no (short-term) association between parenting stress and parents' screen use. Comparably to parental screen use, however, parenting stress is associated with suboptimal parent-child interactions, particularly reduced parental responsiveness (Crnic & Low, 2002) and reduced dyadic pleasure (Crnic & Low, 2005). Given the importance of frequent and diverse parent-child interactions in promoting children's vocabulary development (Hoff, 2003), it is possible that these suboptimal parent-child interactions are somewhat accountable for mediating the relationship between parenting stress and children's receptive vocabulary.

In contrast to the findings of Noel, Peterson and Jesso (2008), however, the present study found no association between parenting stress and children's expressive vocabulary. It is possible, then, that parenting behaviours associated with high levels of parenting stress effect children's expressive and receptive vocabulary differentially, the latter of which may be more susceptible. Moreover, if parents' screen use does in fact mediate the relationship between parenting stress and children's vocabulary ability, which is possible given the finding that parenting stress does indeed positively predict parents' screen use longitudinally (McDaniel & Radesky, 2018), although which remains unclear given the present study failed to establish a short-term association, then it is also possible that the novel finding from the present study, that children's expressive vocabulary may be less susceptible to the effects of technoference during parent-child interactions than children's receptive vocabulary, in fact explains why parenting stress was only negatively associated with children's receptive vocabulary.

Conclusions

Given that the present study not only highlights a differential effect of parents' screen use on children's expressive and receptive vocabulary, but also of parenting stress on children's expressive and receptive vocabulary, it is clear that future research is needed to further investigate longitudinally the triadic relations between parenting stress, parents' screen use and children's vocabulary ability.

Additional research is particularly needed to investigate potential differences in the way children's expressive and receptive vocabularies are affected by parents' screen use, or rather how, or if, the reduced quality and quantity of parental lexical input during instances of technoference affects children's receptive and expressive vocabularies differentially. Moreover, future research is also needed to clarify the possibility that parents' screen use mediates the relationship between parenting stress and children's vocabulary ability.

In conclusion, if parents can accordingly limit the use of their screens whilst in the presence of their child and rather foster quality parent-child interactions, then children's vocabulary will be more advanced, and quality interactions may in fact help buffer SES-related variability in children's vocabulary (Hart & Risley, 2003).

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Appendices are provided as a supplementary file (see download area).