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BRIEF RESEARCH REPORT

Caregiver sensitivity supported young children's vocabulary development during the Covid-19 UK lockdowns

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Abstract

Previous studies have shown that caregivers' sensitive, responsive interactions with young children can boost language development. We explored the association between caregivers' sensitivity and the vocabulary development of their 8-to-36-month-olds during COVID-19 when family routines were unexpectedly disrupted. Measuring caregivers' sensitivity from home interaction videos at three timepoints, we found that children who experienced more-sensitive concurrent interactions had higher receptive and expressive vocabularies (N = 100). Children whose caregivers showed more-sensitive interactions at the beginning of the pandemic showed greater expressive vocabulary growth six (but not 12) months later (n = 58). Significant associations with receptive vocabulary growth were not observed. Our findings highlight the importance of sensitivity at a time when other positive influences on language development were compromised.

Keywords: Interaction quality; vocabulary; Covid-19

Introduction

Maintaining high-quality interactions with young children is a highly beneficial parenting behaviour (Bornstein & Tamis-LeMonda, 1989; Landry, Smith & Swank, 2006). Evidence suggests that high-quality interactions enable the formation of secure attachment (Ainsworth, Blehar, Waters & Wall, 1978), leading to healthy neural, cognitive, and social development (Kivijärvi et al., 2001; Shonkoff & Phillips, 2000). The current study explores the links between caregiver sensitivity and young children's language development during the COVID-19 pandemic.

The quality of caregiver-infant interaction has been conceptualised in various ways and operationalised by multiple measures (see Bohr, Putnick, Lee & Bornstein, 2018 for a review). It is typically coded along several interrelated dimensions that include caregiver behaviours (e.g., sensitivity, cooperation, availability, acceptance, warmth, responsiveness, intrusiveness, happiness, hostility, structuring, engagement, variety, and creativity of behaviour), infant behaviours (e.g., attentiveness, communicativeness, liveliness), as well as measures of the dyadic interaction itself (e.g., smooth, fun; Murray, Fiori-Cowley, Hooper & Cooper, 1996).

Of these dimensions, a key indicator of interaction quality is caregiver sensitivity. Sensitivity is defined as a caregiver's prompt, contingent, and appropriate interaction with their child (Eshel, Daelmans, Cabral De Mello & Martines, 2006), or the accurate interpretation of their child's physical or verbal signals, and their mental states, followed by an appropriate response (Ainsworth et al., 1978). Crucially, sensitive interactions led by caregivers have been shown to benefit infants' physical, cognitive, and socioemotional development (Deans, 2020; Lemelin, Tarabulsy & Provost, 2006; Page, Wilhelm, Gamble & Card, 2010). As such, sensitivity is widely promoted in parenting programmes (e.g., Head Start; Chazan-Cohen, Stark, Mann & Fitzgerald, 2007) and other successful interventions (see Eshel et al., 2006 for a review).

Caregiver sensitivity may become doubly important for the development of children growing up in adverse circumstances – for example, in socioeconomically disadvantaged backgrounds (Eshel et al., 2006; Firk, Konrad, Herpertz-Dahlmann, Scharke & Dahmen, 2018; Madigan et al., 2019). However, these negative conditions may themselves present threats to sensitivity. In a concept analysis of maternal sensitivity, Shin, Park, Ryu and Seomun (2008) identified several influencing factors: three positive (social support, maternal-foetal attachment, and high self-esteem) and three negative (maternal depression, maternal stress, and maternal anxiety). Social networks are a common source of physical, psychological, or financial help, and have a positive relationship with maternal sensitivity (Belsky & Pasco Fearon, 2002; Shin, Park & Mi, 2006). Conversely, maternal mental illness presents risks to the initial mother-infant relationship and the child's development (Dib, Padovani & Perosa, 2019). For example, depression affects mother-infant interactions via feelings of disinterest and guilt (Fernandes & Cotrin, 2013), and anxiety is associated with lower sensitivity (Clavarino et al., 2010), increased maternal intrusiveness, and decreased interactive behaviours among 3-month-olds (Feldman et al., 2009).

The negative impact of COVID-19 on social support and mental health during the pandemic may have disrupted usual levels of stability in maternal sensitivity. In non-pandemic times, maternal sensitivity is generally stable across time, interaction contexts, and measures (Behrens, Parker & Kulkofsky, 2014; Kemppinen, Kumpulainen, Raita-Hasu, Moilanen & Ebeling, 2006; Landry, Smith, Swank, Assel & Vellet, 2001; Leigh, Nievar & Nathans, 2011; though see Belsky & Pasco Fearon, 2002 for evidence of discontinuity). During the pandemic, social support (in the form of caregivers' social networks) was depleted due to social distancing measures. Mental illness rose, particularly among lower income families (Office for National Statistics, 2021) and in women and parents of preschool-age children (Fancourt, Steptoe & Bradbury, 2022; Pierce, Hope, Ford, Hatch, Hotopf, John, Kontopantelis, Webb, Wessely, McManus & Abel, 2020). Thus, it is highly likely that caregiver sensitivity was negatively affected during the pandemic, presenting a risk to children's development.

Here we hone in on the effect on young children's language growth during the pandemic. Our study builds on a large body of evidence showing that children whose primary caregiver responds promptly, contingently, and appropriately to their vocalisations and other behaviours make greater gains in early language skills (Bornstein, Tamis-LeMonda & Haynes, 1999; Madigan et al., 2019 ; Raviv, Kessenich & Morrison, 2004). Longitudinally, maternal sensitivity during the child's first year has been shown to predict both receptive and expressive language in the second and third years of life (Baumwell, Tamis-LeMonda & Bornstein, 1997; Leigh et al., 2011; Murray & Hornbaker, 1997; Neuhauser, Ramseier, Schaub, Burkhardt & Lanfranchi, 2018). In a comprehensive study measuring the impact of multidimensional aspects of responsiveness on significant developmental steps in expressive language, Tamis-LeMonda, Bornstein and Baumwell (2001) showed that maternal responsiveness at 9 and 13 months predicted all measured milestones over and above children's activities.

The benefits of caregiver sensitivity may be especially strong for children at risk of poorer language outcomes. Sensitivity has been found to mediate the relationship between socioeconomic status (SES) and cognitive development (Firk et al., 2018), as well as between SES and expressive and receptive language (Raviv et al., 2004), nuancing the established link between social background and language development (Hoff, 2013). Positive caregiver-child verbal interactions reduce the risks presented by less complex and less diverse language input on three- and four-year-olds' receptive and expressive language (Vernon-Feagans, Bratsch-Hines & The Family Life Project Key Investigators, 2013). Frequent verbal imitations by mothers within highly connected mother-infant pairs mediated the impact of adversity on early communication skills (Smith et al., 2018).

The literature converges to show that caregiver sensitivity supports language development in general circumstances and can provide a valuable buffer for children growing up in adversity. However, we do not yet know how these relationships play out when family routines and social networks are unexpectedly disrupted. The COVID-19 pandemic provides an ideal opportunity to investigate the interplay of caregiver-child interactions, threats such as disrupted mental health and social support, and child language outcomes.

We report an exploratory study investigating how the quality of caregiver-child interactions is associated with young children's vocabulary during the UK lockdowns. Through a focus on children in the first three years of life, we examine the role of caregiver interaction at a crucial developmental stage. We address the following research questions:

1. What is the relationship between caregiver sensitivity and child vocabulary; concurrently and regarding language growth throughout the pandemic?
2. Is any relationship between caregiver sensitivity and child vocabulary mediated by caregiver mental health or social support routines?
3. Is caregiver sensitivity stable throughout successive lockdowns?

Method

Participants

Eight hundred and sixty-one UK-based caregivers and their 8- to 36-month-old children were recruited through University Babylab databases and online adverts via Babylab social media accounts to take part in the Social Distancing and Development study.

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Across the three UK lockdowns (labelled Spring 2020, Winter 2020, and Spring 2021[1]; T1, T2, and T3 respectively) participating caregivers completed online questionnaires about their family circumstances, their child's development and their own mental health. At each timepoint, families were invited to upload a short video recording of the caregiver and their child interacting together. Participation in this aspect of the study was optional and not incentivised. More details of measures collected, and data collection protocols are reported in Hendry et al. (2022).

Only monolingual, English-speaking families where the child had a gestational age of 37 weeks or over, with no known genetic conditions and who uploaded video recording(s) are included in the current study. The sample size, therefore, varied across timepoints (Spring 2020: n = 100; mean child age at test = 21.1m, SD = 7.0, 43% female children. Winter 2020: n = 24, mean child age at test = 27.7m, SD = 7.4, 29% female children. Spring 2021: n = 26; mean child age at test = 33.0m, SD = 6.1; 50% female children). Ninety-five per cent of the adult participants in these interactions were the child's mother, 5% their father. The majority of households were two-parent families (97% in Spring 2020, 96% in Winter 2020 and Spring 2021), educated to degree level or above (80% in Spring 2020, 96% in Winter 2020, and 92% in Spring 2021) and lived in areas in deciles 5-10 of the Indices of Multiple Deprivation (IMD; where 1 is the most deprived; McLennan et al., 2019; 55% in Spring 2020, 92% in Winter 2020, 88% in Spring 2021). See SM 1.1 for comparative demographic information at each timepoint.

Measures

Interaction Quality

Using their own cameras, caregivers made 5-10 minute video recordings of themselves and their child engaging in an activity of their choosing to provide "*a snapshot of life during this exceptional time*". Setup instructions were limited to suggestions for everyday items that could function as tripods, a request to try to ensure all participants were visible on screen and to consider recording at a time when their child was not tired or hungry. Activities in the video recordings included free play, book reading, arts and crafts, and household chores (e.g., cooking; gardening). For each dyad, 5 minutes from the middle of the recording were coded using a modified version of the Global Ratings Scale (GRS; Murray et al., 1996) to produce measures of caregiver and child interactive behaviour. The original scale focused on preverbal infants in a restricted face-to-face interaction. Therefore, we made adaptations to extend the range of potential child communicative behaviours (i.e., vocalisations, words, and gestures) and means by which caregivers could respond to them (i.e., verbal or gestural bids to engage with an object or activity) across a set of contexts commensurate with the ages and diversity of activities in our sample. A trained research assistant watched the recordings and rated caregivers and their infants along multiple dimensions on a 5-item Likert scale. Following Murray et al. (1996), scores on subscales measuring caregiver warmth, acceptance, responsiveness, and sensitivity towards their child were averaged to produce an overall measure of *Caregiver Sensitivity*. Higher scores on this dimension indicate a responsive interactive style where the caregiver warmly responds to their child's cues (with their face, voice or touch) in a way that is appropriately adjusted to the child's behaviour. See Table 1 for a summary of

[1]Precise dates for each wave of data collection were 23 March – 28 June (Spring 2020), 27 November - 18 December 2020 (Winter 2020), 27 April - 2 June 2021 (Spring 2021).

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Table 1. Summary of Modified GRS Caregiver subscales

Subscale	Description
Warmth	This subscale measures the caregiver's attitude and feelings towards the child, with the expression of their love and affection on one hand (e.g., "good girl", "What a nice, big smile", "clever boy"), and their anger and criticism on the other (e.g., "that's not nice", "stop being naughty"). (Warm/Positive - Cold/Hostile in Murray et al., 1996)
Acceptance	This subscale measures how accepting a caregiver is of their child's experience. So, for instance, if the child looks away, moves away, or changes the focus of their activity, does the caregiver follow the child's attention and accept their experience? (e.g., "What are you looking at? Is that window interesting? What are you up to now?"), or conversely, do they criticise or show disappointment? (e.g., "You don't want to play with me do you? "You don't want to eat this for Mummy"). (Accepting - Rejecting in Murray et al., 1996)
Responsiveness	This subscale measures the caregiver's capacity for being aware of the child's signals, and the level of responsiveness to the child's behaviours – this includes both appropriate and inappropriate responses. (Responsive - Unresponsive in Murray et al., 1996)
Sensitivity	This subscale measures globally, how sensitively the caregiver responds to their child in terms of how aware they are of even very subtle child signals and of the child's willingness or reluctance to interact; how they empathise and identify with the child and understand (correctly) what response the child is looking for or is needed at a particular moment; and how responsive the caregiver is to the child's signals and how appropriate their responses are. (Sensitive - Insensitive in Murray et al., 1996)

individual subscales; and SM 1.2 for the more detailed coding scheme. CHILD ENGAGEMENT was measured by averaging scores on two subscales indexing how much the child engaged verbally and non-verbally in the interaction. Higher scores on this measure indicate a child who is more engaged in the interaction with their caregiver. Internal consistency measured using Cronbach's alpha was acceptable for both caregiver ($\alpha = .71$) and child ($\alpha = .72$) measures. A second trained researcher independently coded a random selection of 17 recordings. Cohen's Kappa revealed excellent levels of agreement on coding of caregiver sensitivity ($\kappa = .88$) and good agreement on the child measure ($\kappa = .64$).

Child Language

The Oxford CDI (Oxford Communicative Development Inventory; O-CDI; Hamilton, Plunkett & Schafer, 2000), a caregiver-report measure of child RECEPTIVE AND EXPRESSIVE VOCABULARY was collected at each timepoint. Caregivers were asked to record which of 564 early vocabulary words their child 'understood' or 'understood and said'. To calculate VOCABULARY GROWTH, we subtracted the O-CDI score at either Winter 2020 or Spring 2021 from the equivalent measure collected in Spring 2020. By Spring 2021, many children participating in the study had reached the upper age limit of the O-CDI, so a bespoke caregiver checklist of receptive and expressive vocabulary, the CLT (British English version of the Cross-Linguistic Lexical Task, based on Haman, Łuniewska & Pomiechowska, 2015), was also administered. Details of the CLT creation and items are presented in SM 1.3.

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Caregiver Mental Health

The Depression Anxiety and Stress Scale (DASS-21) was collected at each timepoint to measure caregiver's DEPRESSION, ANXIETY and STRESS (Lovibond & Lovibond, 1995). Reflecting on the last week, adult participants rated on a 4-item Likert scale the extent to which each of the 21 statements applied to them. Higher scores (maximum = 42) indicate more severe symptoms of psychological distress. Following Hendry et al. (in revision), we also calculated a measure of chronic mental health difficulties. A dichotomous variable was calculated for each participant if they scored in the mild – extremely severe clinical range for anxiety, depression, or stress at each timepoint. These were summed across time to produce a score (0-3) indicating chronicity of symptoms across the data collection period.

Social Support

In Winter 2020 and Spring 2021, adult participants completed the Medical Outcomes Study Social Support Survey (Sherbourne & Stewart, 1991). Using a 5-item Likert scale, respondents estimated the amount of SOCIAL SUPPORT that was available to them across 19 items tapping four domains (sources of advice, practical support, emotional connection, and friendship). A composite score (0-100, where higher scores indicate more support) was calculated following Sherbourne and Stewart's (1991) guidelines.

Analytic strategy

All analyses were conducted in R Studio (RStudio Team, 2020) using the MASS package (Venables & Ripley, 2002). Negative binomial regression was used to model both concurrent vocabulary and vocabulary growth. Vocabulary measured using the O-CDI produces an over-dispersed count variable, and negative binomial models can better fit this type of data than linear regression (Smithson & Merkle, 2013). Measures of caregiver sensitivity and child engagement were grand mean centred in all models. To account for the wide child age range in our sample, and the inherently dyadic nature of interaction, child age, and child engagement in the interaction were included as control variables in all models. Measures of SES (caregiver education and IMD) were considered as additional control variables. These were not significant predictors in any model of concurrent or language growth and did not improve model fit (using AIC comparison: Akaike Information Criterion). Model summaries and AIC values are reported in SM 1.4.

Results

Longitudinal descriptive statistics for respondents who contributed video recordings in Spring 2020 are presented in Table 2. Interactions were characterised by high levels of caregiver sensitivity and child engagement. Caregiver mental health scores were overall within the normal range. As expected, receptive and expressive vocabulary scores increased as children grew older.

We first considered the relationship between caregiver sensitivity and concurrent child vocabulary in Spring 2020 (Table 3). Negative binomial regression models fit to receptive vocabulary (N = 100, log-likelihood = −1258.98, overdispersion estimate = .38) revealed effects of child age and caregiver sensitivity such that older children and those who experienced more sensitive concurrent interactions had a larger caregiver-reported

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Table 2. Descriptive statistics for longitudinal measures for respondents who contributed video recordings in Spring 2020

	N	Mean	SD	Min	Max	Median
Spring 2020 (T1)						
Child Age (in months)	100	21.15	7.04	8	36	20
Caregiver Sensitivity	100	4.4	0.4	2.63	5	4.33
Child Engagement	100	3.8	0.8	1.88	5	4
Expressive Vocabulary	100	196.28	191.77	0	529	142
Receptive Vocabulary	100	294.44	178.70	0	539	309
Caregiver Anxiety	89	3.84	5.21	0	22	2
Caregiver Depression	89	7.33	7.66	0	40	6
Caregiver Stress	89	13.22	9.11	0	38	10
Winter 2020 (T2)						
Child Age (in months)	58	27.69	6.94	16	43	27
Expressive Vocabulary	58	344.95	186.44	0	546	421.5
Receptive Vocabulary	58	442.22	109.88	114	546	477.5
Expressive Language Growth	58	164.4	128.12	0	459	129.5
Receptive Language Growth	58	153.44	99.92	9	316	151.5
Caregiver Anxiety	52	3	4.97	0	24	2
Caregiver Depression	52	5.77	5.77	0	20	4
Caregiver Stress	52	11	8.06	0	34	10
Spring 2021 (T3)						
Child Age (in months)	65	33	6.44	22	48	32
Expressive Vocabulary	65	448.8	117.33	32	548	492
Receptive Vocabulary	65	502	52.22	190	548	516
Expressive Vocabulary Growth	65	261.6	152.81	10	520	269
Receptive Vocabulary Growth	65	201.4	135.99	9	433	196
Caregiver Anxiety	57	3.12	6.11	0	32	0
Caregiver Depression	57	4.7	6.22	0	24	2
Caregiver Stress	57	8.53	6.53	0	34	6

receptive vocabulary. In an equivalent model fit to expressive vocabulary (N = 100, log--likelihood = −1106.78, overdispersion estimate = .89), child age and concurrent sensitive caregiver interactions were again significant positive predictors, this time alongside child engagement.

RQ1. What is the relationship between caregiver sensitivity and child vocabulary; concurrently and regarding language growth throughout the pandemic?

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Table 3. Negative Binomial Models fit to concurrent Child Vocabulary in Spring 2020

	Receptive				Expressive			
	B (95% CI)	*SD*	*Z*	*p*	B (95% CI)	*SD*	*Z*	*p*
Intercept	3.14	0.22	14.20	< .001	–0.38	0.35	1.11	0.27
	(2.63, 3.65)				(–1.24, .50)			
Caregiver Sensitivity	0.14	0.07	2.17	0.03	0.28	0.10	2.67	< .01
	(−.00, .29)				(0.06, .49)			
Child Engagement	0.01	0.07	0.19	0.84	0.27	0.11	2.45	< .05
	(−.12, .15)				(0.06, .48)			
Child Age	0.11	0.01	11.08	< .001	0.23	0.02	14.98	< .001
	(.09, .13)				(0.19, .27)			

Table 4. Negative Binomial Models fit to O-CDI Vocabulary Growth in Winter 2020

	Receptive Growth				Expressive Growth			
	B (95% CI)	*SD*	*Z*	*p*	B (95% CI)	*SD*	*z*	*p*
Intercept	6.69	0.26	25.25	< .001	5.24	0.39	13.42	< .001
	(6.16, 7.23)				(4.39, 6.12)			
Caregiver Sensitivity	0.04	0.07	0.48	0.63	0.25	0.11	2.29	0.02
	(−.13, .19)				(.02, .46)			
Child Engagement	0.01	0.09	0.13	0.90	0.01	0.13	0.10	0.92
	(−.15, .17)				(−.23, .25)			
Child Age	–0.08	0.01	–7.11	< .001	–0.01	0.02	–0.41	0.68
	(−.11, −.06)				(−.04, .03)			

Next, we built models to explore the relationship between caregiver sensitivity in Spring 2020 and child vocabulary growth across the pandemic study period. With respect to O-CDI receptive vocabulary growth, older children were reported to have learned fewer words between Spring 2020 and Winter 2020 (Table 4; N = 58, log-likelihood = −655.78, overdispersion estimate = .33) and between Spring 2020 and Spring 2021 (Table 5; N = 65, log-likelihood = −753.46, overdispersion estimate = .27), with no other predictors showing a significant effect. For O-CDI expressive vocabulary, caregiver sensitivity was positively associated with growth between Spring 2020 and Winter 2020 (N = 58, log-likelihood = −701.42, overdispersion estimate = .73), but not between Spring 2020 and Spring 2021 (N = 65, log-likelihood = −820.423, overdispersion estimate = .40). Older children were reported to have learned fewer words between Spring 2020 and Spring 2021 (only).

RQ2. Is any relationship between caregiver sensitivity and child vocabulary mediated by caregiver mental health or social support routines?

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Table 5. Negative Binomial Models fit to O-CDI Vocabulary Growth in Spring 2021

	Receptive Growth				Expressive Growth			
	B (95% CI)	*SD*	*Z*	*p*	B (95% CI)	*SD*	*Z*	*p*
Intercept	7.32	0.26	28.28	< .001	6.83	0.31	22.05	< .001
	(6.82, 7.83)				(6.21, 7.47)			
Caregiver Sensitivity	0.02	0.06	0.28	0.78	0.10	0.08	1.31	0.19
	(−.11, .13)				(−.05, .24)			
Child Engagement	−0.03	0.08	−0.40	0.69	0.02	0.10	0.18	0.85
	(−.19, .11)				(−.16, .19)			
Child Age	−0.10	0.01	−8.87	< .001	−0.06	0.01	−4.48	< .001
	(−.12, −.08)				(−.09, −.03)			

We next explored whether caregiver anxiety, depression, or stress mediated the relationships between concurrent vocabulary and caregiver sensitivity in Spring 2020 and expressive vocabulary growth in Winter 2020. Caregiver mental health was not significantly correlated with caregiver sensitivity, or child vocabulary at either timepoint (Figure 1). Since previous work has suggested that chronic caregiver mental health problems present the highest risk for child outcomes, we considered our measure of persistent mental health challenges in Winter 2020 as a mediating factor. There was no relationship between

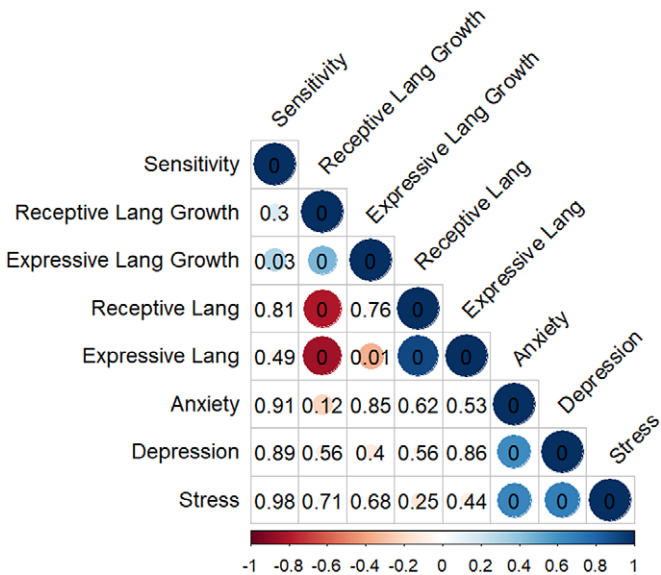

Figure 1. Correlations with significance levels between caregiver sensitivity, mental health, and child vocabulary in Winter 2020 and vocabulary growth in Spring 2021

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chronic mental health and caregiver sensitivity (r = .05, p = .71) or expressive vocabulary growth (r = −.09, p = .51). Grounds for mediation were, therefore, not met.

We did not measure social support routines in Spring 2020, and were therefore unable to explore any mediating effects at this time point. However, as explained below, a post-hoc secondary analysis of correlations between social support, caregiver sensitivity and child vocabulary in Winter 2020 and Spring 2021 revealed no relationship between social support and sensitivity at either timepoint.

RQ3. Is caregiver sensitivity stable throughout successive lockdowns?

A subset of families from the initial Spring 2020 sample (n = 26) also provided video-recorded interactions at at least one further time point (Table 6). Caregiver sensitivity in Spring 2020 was positively associated with the same measure taken both 6 months (n = 20, r = .53, p = .02) and one year later (n = 20, r = .53, p = .02). Caregiver sensitivity in Winter 2020 showed a non-significant positive association with caregiver sensitivity in Spring 2021 (n = 13, r = .41, p = .17)[2].

We conducted a series of post-hoc secondary analyses to further our understanding of concurrent relationships between caregiver sensitivity, vocabulary, and potential influencing factors by considering video data collected in Winter 2020 and Spring 2021. Descriptive statistics for these subsamples are presented in Table 7. We adopted a different analytic strategy here in line with the reduced statistical power at these timepoints. In the first instance, for models predicting the relationships between concurrent sensitivity and child vocabulary since vocabulary showed a large association with age in these sub-samples, we regressed vocabulary scores on age and used the residuals in analyses. In Winter 2020, caregiver sensitivity (B = 34.00, SD = 14.95, p < .05) and child engagement (B = 38.36, SD = 14.62, p < .05) were significant positive predictors in a linear model fit to O-CDI receptive vocabulary (R2adj = .25, p < .05). An equivalent model fit to O-CDI expressive vocabulary was not significant (R2adj = .03, p = .29). In Spring 2021, child engagement remained a significant positive predictor of the number of words that caregivers reported their children understood (B = 12.51, SD = 4.06, p < .01; R2adj = .36, p < .01) and said (B = 40.42, SD = 14.31, p < .01; R2Adj = .25, p < .05). Models fit to child receptive (R2Adj = .09, p = .91) and expressive (R2Adj = .01, p = .36) vocabulary measures using the CLT checklist were not significant.

In the second instance, to develop our understanding of mental health and social support, we ran a series of correlations to consider the concurrent relationships between these measures, caregiver sensitivity and child vocabulary in Winter 2020 and Spring 2021 (Figure 2). There was no relationship between sensitivity and these influencing factors at either timepoint.

Table 6. Descriptive Statistics for repeated measures of Caregiver Sensitivity across all timepoints

Caregiver Sensitivity	*N*	Mean	*SD*	Min	Max	Median
Spring 2020	27	4.3	0.5	2.6	5	4.3
Winter 2020	20	4.3	0.4	3.5	5	4.3
Spring 2021	20	4.2	0.2	3.8	4.5	4.3

[2]To detect a moderate to strong correlation using a two sided test with 5% significance level (α = 0.05) and with power 80% power (β = 0.2) the required sample size is 47.

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Table 7. Descriptive data from respondents contributing video data in Winter 2020 and Spring 2021

	N	Mean	SD	Min	Max	Median
Winter 2020						
Child Age (in months)	24	27.70	7.42	17.46	43.2	27.37
Caregiver Sensitivity	24	4.3	0.4	3.5	4.9	4.3
Child Engagement	24	4.0	0.7	2	4.5	4
Expressive Vocabulary	24	338.8	205.1	16	546	454.5
Receptive Vocabulary	24	436.8	124.1	146.0	546	505.0
Caregiver Anxiety	24	3.33	5.49	0	24	0
Caregiver Depression	24	5.67	5.13	0	18	6
Caregiver Stress	24	10.5	7.37	0	26	10
Social Support	24	85.42	15.78	44.74	100	90.79
Spring 2021						
Child Age (in months)	26	32.98	6.05	22	48	32
Caregiver Sensitivity	26	4.2	0.2	3.8	4.5	4.3
Child Engagement	26	3.4	0.8	1.5	5	3.4
Expressive Vocabulary	26	469.3	86.6	144	542	496.5
Receptive Vocabulary	26	510.5	31.2	419	545	513.5
CLT Expressive Vocabulary	24	49.50	14.03	30	76	50
CLT Receptive Vocabulary	24	57.54	11.37	33	76	57.50
Caregiver Anxiety	26	2.77	5.60	0	24	0
Caregiver Depression	26	5.692	6.16	0	22	4
Caregiver Stress	26	8.62	6.59	0	28	8
Social Support	26	80.31	19.52	30.26	100	84.21

Discussion

We investigated the impact of caregiver sensitivity on child language in a cohort of UK families during the first year of the COVID-19 pandemic. Our primary research question probed the relationship between caregiver sensitivity and child vocabulary, concurrently and on its growth throughout the pandemic study period. In Spring 2020 (T1), we found that children who experienced more-sensitive concurrent interactions had higher caregiver-reported receptive and expressive vocabularies than their peers experiencing less-sensitive interactions. Children experiencing more-sensitive interactions in Winter 2020 (T2) also showed larger concurrent receptive vocabularies. This association was not replicated at the final timepoint (Spring 2021; T3), nor did it hold for expressive vocabulary beyond the first timepoint.

Considering language growth, we found that children whose caregivers showed more-sensitive interactions at the beginning of the pandemic had greater expressive vocabulary growth six months later. This effect did not endure to subsequent timepoints or extend to receptive vocabulary growth at any timepoint. We discuss potential explanations below.

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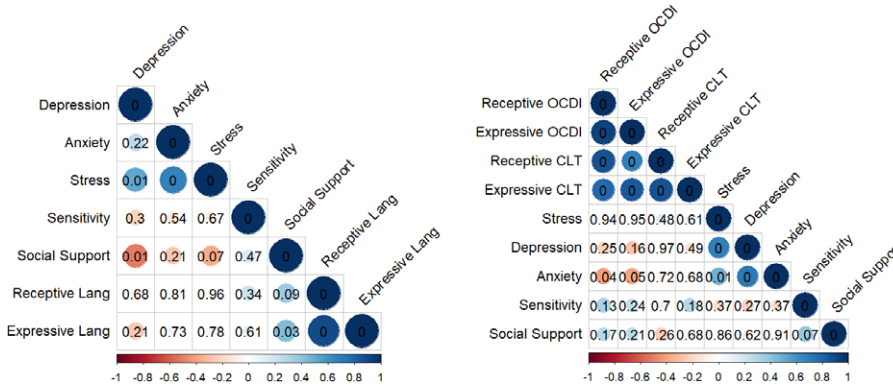

Figure 2. Correlations with significance levels between caregiver sensitivity, mental health, and child vocabulary in Winter 2020 (L) and Spring 2021 (R).

The association between sensitivity and language growth chimes with other research with young children during the pandemic. Kartushina, Mani, Aktan-Erciyes, Alaslani, Aldrich, Almohammadi, Alroqi, Anderson, Andonova, Aussems, Babineau, Barokova, Bergmann, Cashon, Custode, De Carvalho, Dimitrova, Dynak, Farah, Fennell, Fiévet, Frank, Gavrilova, Gendler-Shalev, Gibson, Golway, Gonzalez-Gomez, Haman, Hannon, Havron, Hay, Hendriks, Horowitz-Kraus, Kalashnikova, Kanero, Keller, Krajewski, Laing, Lundwall, Łuniewska, Mieszkowska, Munoz, Nave, Olesen, Perry, Rowland, Santos Oliveira, Shinskey, Veraksa, Vincent, Zivan, and Mayor (2022) found greater vocabulary growth during lockdown than expected (based on normative data), and a relationship between vocabulary growth and parent-child reading activities. They suggest that toddlers may have benefited from more intensive caregiver-child interaction during the pandemic, which may have also been more sensitive in nature.

Our data show that sensitivity did not predict expressive and receptive vocabulary in the same way over time in our cohort. It was associated with both aspects concurrently in Spring 2020, with receptive vocabulary concurrently in Winter 2020, and with expressive vocabulary growth in Winter 2020. Comparable literature[3] also shows an asymmetry. Murray and Hornbaker (1997) and Neuhauser et al. (2018) found that sensitivity was predictive of receptive but not expressive growth at 24 months, both citing the relative instability of expressive language at this point in development, potentially compounded by measurement error stemming from elicitation methods for very young children. Paavola, Kemppinen, Kumpulainen, Moilanen and Ebeling (2006) found a similar pattern, hypothesising that sensitive mothers may better support their child's learning style, leading to gains in receptive language. Maternal sensitivity was found to explain more of the variance in receptive than expressive models by Raviv et al. (2004). Discussing this converging evidence, Raviv et al. (2004) suggest that environmental input such as caregiver sensitivity strongly influences receptive language, whereas other factors (e.g., maturation) may be more important for expressive language. Regarding this stronger association with receptive

[3]Extant studies focus only on either expressive (e.g., Leigh et al., 2011) or receptive growth (Baumwell et al., 1997), or only on concurrent expressive (Bornstein et al., 1999), or do not disaggregate receptive/ expressive skills in meta-analyses (Madigan et al., 2019), making it challenging to form hypotheses about the effect of sensitivity on children's emerging expressive and receptive skills.

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language, it may be that a caregiver shows more sensitivity if their child can understand what they say. Further, a caregiver who reports lower receptive language in their child may demonstrate sensitivity in ways that are less easy to pick up in video coding, e.g., touch, facial expression, etc. We welcome future theoretical and empirical work that investigates the distinct influence of sensitivity on receptive versus expressive language.

Overall, our data align with evidence showing that children whose primary caregiver responds to them sensitively show stronger language skills both concurrently and longitudinally in the first three years of life (Baumwell et al., 1997; Bornstein et al., 1999; Leigh et al., 2011; Madigan et al., 2019; Murray & Hornbaker, 1997; Neuhauser et al., 2018; Paavola et al., 2006; Raviv et al., 2004; Tamis-LeMonda et al., 2001). These effects appear to be relatively short-lived in our data. However, there are limitations to the conclusions we can draw. Firstly, our test instruments may have obscured language growth as children reached the end of the study period. Our results revealed that age was a significant negative predictor of language growth in Winter 2020 and Spring 2021. The observation that older children's language grew less is likely due to them reaching the ceiling of the O-CDI (26 months) at the final timepoint (mean age 33 months; max = 48). This ceiling effect has implications for what can be inferred about the impact of sensitivity across the developmental timeframe in this sample: effects may only be visible at younger ages concurrently, or in the short-term provided there is sufficient variance in the measure (as we find with expressive vocabulary growth in Winter 2020). Secondly, our relatively small sample size at the Winter 2020 and Spring 2021 timepoints (n = 24 and 26, respectively) and the modelling choices they afforded may have contributed to null effects at these later timepoints.

Our second research question examined the influence of environmental factors on sensitivity and language. Drawing from Shin et al.'s (2008) framework, we focused on caregiver mental health (as a negative influencing factor) and social support (as a positive influencing factor) on the relationship between caregiver sensitivity and child vocabulary as the pandemic wore on. Neither mental health (chronic or otherwise) nor social support was associated with sensitivity at either tested timepoint (Winter 2020, Spring 2021), meaning that a mediation analysis was not licensed. This dissociation was somewhat surprising in light of previous research finding that depression and anxiety impede mother-infant interactions (Clavarino et al., 2010; Fernandes & Cotrin, 2013) and that social networks have a significant positive relationship with maternal sensitivity (Shin et al., 2006, i.a.). It may be that the extreme changes to the forms of social support permitted during the pandemic do not facilitate sensitivity in the same way as pre-pandemic social support. Another possibility is that this dissociation is due to our self-selected sample, as parents with poor mental health and a lack of social support were probably less likely to film themselves and submit a video (see limitations for further discussion).

Our final research question probed the stability of caregiver sensitivity throughout successive lockdowns. In line with the literature (Behrens et al., 2014; Kemppinen et al., 2006; Landry et al., 2001; Leigh et al., 2011), we found sensitivity remained consistent over our study period, demonstrating the resilience of caregivers during the adverse circumstances presented by the pandemic.

Limitations and Conclusions

Due to limitations with instrument sensitivity and sample size, later associations between sensitivity and language may have been masked as the pandemic continued into 2021. We

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appeal for future work to develop an easily-administered/caregiver-reported, standardised vocabulary measure which spans infancy to the preschool years.

Variance in levels of measured sensitivity was also limited in our data. Overall, caregiver sensitivity was high, which was somewhat against our expectations for caregiver behaviour during times of adversity. This may be linked to the mental health of our sample (which was within the normal range), enabling them to record and submit videos at a time of high domestic and professional demands. They may have also selected videos showing enhanced interaction quality. Although these factors should be acknowledged when assessing the generalisability of our findings, we would also highlight the naturalism inherent in the activities depicted in the videos, compared with other work which measures caregiver sensitivity using specified, observed activities.

We also acknowledge that manifestations of sensitivity are culturally bound. Our coding scheme is derived from literature in which parent-child interaction styles associated with white, Western, neurotypical, socioeconomically-advantaged families are held up as the ideal. It also emphasises verbal or more extraverted manifestations of sensitivity, rather than physical signs which may align with a more proximal nature of caregiver–infant interactions in some non-Western populations (e.g. Kärtner, Keller & Yovsi, 2010). Thus, our measure may miss caregiver behaviours that support development in more diverse family contexts. Future work should seek to identify measures that capture culturally-diverse aspects of caregiver sensitivity, as linked to healthy child development (Bohr et al., 2018; Mesman et al., 2018).

Future work addressing these limitations should provide insights into the holistic understanding of how caregiver-child interactions, mental health, the social environment, and language development interrelate. This will represent a significant expansion of research that has previously been limited to analyses of individual factors in language growth. Furthermore, a more fine-grained coding of the data will allow a deeper understanding of these relationships.

This exploratory study has revealed a positive relationship between caregiver sensitivity and children's vocabulary development during the Covid-19 pandemic. Our findings highlight the robustness of caregiver resourcefulness during this novel type of adversity and emphasise the importance of sensitivity for young children's development at a time when other positive influences on language development were compromised, e.g., access to high-quality Early Childhood Education and Care (Davies et al., 2021).

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