


BRIEF RESEARCH REPORT

# Maternal input, not transient elevated depression and anxiety symptoms, predicts 2-year-olds' vocabulary development

Nan Xu Rattanasone<sup>1,2</sup> , Ruth Brookman<sup>3,4</sup>, Marina Kalashnikova<sup>5,6</sup>, Kerry-Ann Grant<sup>7</sup>, Denis Burnham<sup>3</sup> and Katherine Demuth<sup>1</sup>

<sup>1</sup>Centre for Language Studies, Department of Linguistics, Faculty of Medicine, Health and Human Sciences, Macquarie University; <sup>2</sup>Multilingual Research Centre, Faculty of Medicine, Health and Human Sciences, Macquarie University; <sup>3</sup>The MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Australia; <sup>4</sup>School of Psychology, Western Sydney University, Australia; <sup>5</sup>BCBL, Basque Center for Cognition, Brain and Language, San Sebastian, Spain; <sup>6</sup>IKERBASQUE, Basque Foundation for Science, Bilbao, Spain and <sup>7</sup>Health Education and Training Institute, St Leonards, NSW, Australia

**Corresponding author:** Nan Xu Rattanasone; Email: [nan.xu@mq.edu.au](mailto:nan.xu@mq.edu.au)

(Received 21 February 2023; revised 05 July 2024; accepted 04 August 2024)

## Abstract

Both the quantity and quality of the maternal language input are important for early language development. However, depression and anxiety can negatively impact mothers' engagement with their infants and their infants' expressive language abilities. Australian mother–infant dyads ( $N = 30$ ) participated in a longitudinal study examining the effect of maternal language input when infants were 24 and 30 months and maternal depression and anxiety symptoms on vocabulary size. Half the mothers had elevated depression and anxiety symptoms during at least one point in the study (at 6, 12, 18, 24, or 30 months). The results showed that only maternal input measures (word tokens, types, and mean length of utterance) predicted vocabulary size. While no evidence was found that brief periods of maternal depression and anxiety negatively impacted early vocabulary development, the findings highlight the critical importance and possible mitigating effects of maintaining good quality mother–infant interactions during early development.

**Keywords:** maternal input; vocabulary; maternal depression; maternal anxiety; toddlers

Early language skills are among the broadest predictors of childhood outcomes, including academic achievements (Pace et al., 2019). During the first years of a child's life, language development is supported by the quality and quantity of caregiver language input, which varies across infants and caregivers as a function of numerous factors. These include maternal–infant interactions, which can be impacted by postnatal depression and anxiety. Postnatal depression and anxiety are common conditions that often present together during the postnatal period and can be very debilitating (Matthey et al., 2003; Reck et al., 2012; Farr et al., 2014). There is some evidence to suggest that maternal anxiety

© Macquarie University, 2024. Published by Cambridge University Press. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted re-use, distribution and reproduction, provided the original article is properly cited.

and depression are associated with an increased risk of poor language outcomes in infants (e.g., Kaplan *et al.*, 2014; Reck *et al.*, 2018). Understanding any direct and indirect effects of these conditions on maternal input and later child language outcomes is important for informing any early interventions. Here, we investigate the effects of maternal language input on children's early vocabulary development from 24 to 30 months as part of a larger longitudinal study tracking child development and maternal depression and anxiety symptoms from birth to 30 months.

### Maternal input and vocabulary development

One view of language development is that it is socially mediated (Kuhl, 2007). Mothers, who are often the primary caregivers, provide input that helps scaffold language development through maternal–child interactions. These early interactions are critical to later language development. For example, the classic Hart and Risley (1995) study revealed that cumulative maternal input profoundly impacted children's vocabulary development. More recently, there has been a recognition that both the *quantity* (e.g., number of words) and *quality* of maternal input (e.g., word complexity, diversity, etc.) are important, with *quality* possibly gaining importance as children's language develops. A study that compared quantity (word tokens) against diversity (word types) in computational models of input suggests that lexical diversity grows in importance with child age along with children's expanding vocabularies (Jones & Rowland, 2017). Similarly, while the quantity of maternal input at 18 months predicted children's vocabulary at 30 months, parents' vocabulary diversity but not quantity at 30 months predicted children's vocabulary at 42 months (Rowe, 2012). As children's language skills develop, maternal input becomes more complex not just in terms of lexical but also in syntactic and grammatical complexity, as measured using mean length of utterance (MLU). For 2-year-olds, in addition to lexical complexity, MLU is also predictive of child vocabulary development (Hoff & Naigles, 2002). These research findings suggest that while infants initially require large quantities of input to kick start their vocabulary learning, once the process takes off during the third year of life, children need diverse *quality* of input (e.g., increasing word diversity and MLU) to develop more complex vocabulary and language use.

### Effects of postnatal depression and anxiety on maternal input

During the first 3 months after birth, up to 1 in 5 mothers experience symptoms of postnatal depression (Gavin *et al.*, 2005). These symptoms are similar to those of major depressive disorder and can include a loss of appetite, sleep disturbance, loss of interest in pleasurable activities, agitation, concentration difficulties, feelings of guilt and worthlessness, and suicidal thoughts (DSM-5-TR, 2022). Anxiety disorders commonly co-occur with postnatal depression and include generalised anxiety, specific phobias, and panic disorders (DSM-5-TR, 2022), with an estimated prevalence ranging from 3% to 43% in Western societies (Leach *et al.*, 2017).

All of the above symptoms could have profound impacts on how well mothers function in their everyday lives, including how they interact with their children, affecting the *quantity* and *quality* of mother–infant communicative interactions. For example, postnatal depression has been linked to a reduced number of words spoken, fewer conversational turns, and reduced maternal sensitivity (Brookman *et al.*, 2020a; Campbell *et al.*, 2007; Clifford *et al.*, 2022). For instance, maternal depression symptoms were shown to be associated with decrease in the amount/quantity of child-directed speech (Scheiber *et al.*,

2022), a special speech register used with young children and adapted to their cognitive and linguistic needs. Despite these findings on the direct impact of maternal depression symptoms on maternal input, a recent systematic review reported discrepant findings on the role of maternal depression on children's receptive and expressive language development (Clifford et al., 2024). Detecting maternal depression as having a negative impact on children's language development is more likely with chronic depression and/or in children older than 1 year (Clifford et al., 2024). This suggests that prolonged depressive symptoms may affect the social dynamic of maternal–child interactions, leading to poorer language outcomes, whereas similar effects may not be observed for mother–infant dyads in which the mother has experienced transient depressive symptoms.

Much less is known about the effect of maternal *anxiety* on language development. Postnatal anxiety symptoms can also significantly impair daily functioning (Barlow, 2004), which could impact the quality of mother–infant interactions (e.g., Nicol-Harper et al., 2007) and potentially have negative consequences for child language development. For example, 12-month-olds of mothers with anxiety scored significantly lower on the language subtests of the Bayley-III than controls (Reck et al., 2018). However, whether maternal anxiety negatively impacts the quantity and quality of maternal input to infants is less known. This is partly due to the high comorbidity of depression and anxiety conditions (Leach et al., 2017) and depression masking anxiety symptoms (Grant et al., 2008; Kaitz et al., 2010). As it is not always possible to understand the independent effects of postnatal depression and anxiety disorders on infants' development, recent studies have considered the two conditions together in a single community sample. For example, Brookman et al. (2020a) studied a community group of mothers with and without elevated depression and/or anxiety and showed that fewer mother–infant conversational turns and infant vocalisations at six and 12 months were linked to elevated depression and/or anxiety symptoms, and individual variations in conversational turns and number of vocalisations at these earlier points of development predicted infants' expressive vocabulary size at 18 months. Similarly, while levels of maternal depression and anxiety symptoms predicted infants' vocabulary size at 18 months in a subgroup of this community sample, maternal responsiveness (contingent on infants' needs) was a stronger predictor (Brookman et al., 2023). Both studies thus suggest that it is through maternal input that both depression and anxiety may influence early language development.

### *About this study*

This study investigated the effects of maternal language input on children's early vocabulary development from 24 to 30 months as part of a larger longitudinal study tracking child development and maternal depression and anxiety symptoms from birth to 30 months.

The study included a subset of mother–infant dyads from the longitudinal cohort from Brookman et al. (2020a, b, 2023).

Following Brookman et al. (2020a, b, 2023), we performed two approaches for treating maternal depression and anxiety scores: categorical and continuous. First, we allocated mother–infant dyads to a risk or no-risk control group, that is, based on the mothers' diagnosis and/or elevated symptoms of depression and anxiety (reaching a clinical threshold) at any sampling point during their participation in the larger project (when their infants were from 6 to 30 months of age). This addresses our **first research question about clinical status**: whether having clinical diagnosis/clinical levels of symptoms negatively impact early language development (expressive vocabulary size).

Second, concurrent data for this study (when infants were 24 and 30 months of age) from the entire sample were collapsed, placing mothers on a continuum of current depression and anxiety measures. This addresses our **second research question about timing**: whether having concurrent higher levels of symptoms negatively impacts language development (expressive vocabulary size).

Given that mothers' depression and anxiety scores may have changed over the two years since their child's birth, we expect that higher concurrent anxiety and depression scores (not historical clinical status) may have a negative effect on child vocabulary development.

Finally, for each research question (RQ), we also explore any interactions between a history of clinical symptoms (RQ1) and/or higher concurrent symptoms (RQ2) with maternal input measures. Given that this study focuses on children's language development in the third year of life, our analyses focussed on input quality and quantity measures that are significant predictors of children's language abilities in this age range (Rowe, 2012). We predicted that if maternal depression and anxiety symptoms affected the quality of the input, then mothers with a history or concurrent elevated scores would have lower maternal input measures (quantity and diversity of words, as well as input complexity (MLU)), which will predict smaller expressive vocabulary size.

## Method

### Sample

Thirty mother-infant dyads (12 female infants) participated, with 15 in the risk group and 15 in the control group. Mothers commenced the study when their infants were six months old. This article reports on data collected at 24 and 30 months. To account for the potential variation in the *severity* and *persistence* of symptoms of maternal emotional health concerns during the postnatal period, which is known to influence child development outcomes, mean postnatal depression scores and mean postnatal anxiety scores at six, nine, 12, 18, 24, and 30 months (see Maternal measures below) were calculated for each participant by averaging scores obtained at each data collection point (see Supplementary Materials, S1, for details). Mothers were allocated to the risk group if they: (i) had a self-reported current diagnosis of depression or anxiety or (ii) depression and or anxiety scores, either or both of which exceeded the clinical threshold (i.e., CESD-R  $\geq 16$ ; State-Trait Anxiety Inventory [STAI]  $\geq 40$ ) at any of the six testing time points. The remaining mothers were allocated to the control group. Mother-infant dyads remained in the risk group for the duration of the study despite potential changes to their emotional health scores due to evidence that impaired mother-infant interaction styles can persist beyond the remission of depression with ongoing risks to infant developmental outcomes (e.g., Murray *et al.*, 2010).

All infants were born into households with two heterosexual parents, full-term (37–42 weeks), with normal birth weight and no history of birth or postnatal complications. Infants were acquiring English in a monolingual context and were not exposed to a second language, and they had no reported hearing difficulties, neurological conditions, or health problems. As a measure of socioeconomic status, mothers reported their highest education level, with most having a graduate degree or above (13 in the risk group and 12 controls).<sup>1</sup> This study was approved by the [blind for review] Human Research Ethics Committee [approval number: H11703]

<sup>1</sup>This sample did not differ in maternal education between the risk and control groups (for details see Brookman *et al.*, 2020a).

## Instruments

### *Maternal measures*

All mothers completed self-reported measures of both depression and anxiety symptomatology. The Centre for Epidemiologic Studies Depression Scale-Revised (CESD-R) was used to measure depression symptoms (Eaton et al., 2004). The CESD-R is a 20-item self-reported scale of depressive symptoms and has been used widely with maternal populations in the perinatal period (Engle, 2009). The total score ranges from 0 to 60, with higher scores indicating more severe depressive symptoms. A total score of  $\geq 16$  indicates clinically significant levels of depression. It has excellent psychometric properties, including strong factor loadings, high internal consistency, and theoretically consistent convergent and divergent validity (Van Dam & Earleywine, 2011).

The State Scale of the STAI was used to measure anxiety symptoms (Spielberger et al., 1983). The total score ranges from 20 to 80 with higher scores indicating more severe state anxiety symptoms. Scores of 20 to 39 are considered low anxiety and scores of  $\geq 40$  have been used to indicate clinical or high levels of state anxiety in childbearing women in prior Australian studies. The STAI is a reliable and valid measure of current self-reported anxiety that is one of the most commonly used measures to capture clinical and subclinical anxiety levels (Spielberger et al., 1983; Glasheen et al., 2010). The STAI has demonstrated good internal consistency in prior Australian studies with childbearing women (Grant et al., 2008).

### *Maternal input measures*

Recordings of 10-minute mother-infant free play sessions using an iPad were collected in a sound-treated laboratory room. In each session, mothers were provided with a box of toys and were asked to engage in play with their children using these toys. Maternal speech was transcribed using the CLAN software (MacWhinney, 2000). The MLU using words (MLUw) as well as word types and tokens were extracted from the transcriptions. The transcriptions were conducted by trained intern students enrolled in undergraduate linguistic courses, and the first author checked all transcriptions for accuracy.

### *Infant measure: expressive vocabulary checklist*

When the infants were 24 and 30 months of age, mothers were invited to complete the Australian English adaptation of the MacArthur-Bates Communicative Inventory (Fenson, 2007), known as the OZI (Kalashnikova et al., 2016). Mothers were asked to identify words on the checklist that their children could produce.

## Results

Two linear mixed-effects models were created and analysed using jamovi and R (Gallucci, 2019; R Core Team, 2021; The jamovi project, 2021). The maximal random-effects models allowed by the data are presented. See Table 1 for descriptive information on depression, anxiety, vocabulary, MLU, word tokens, and types.

The first model addressed our first RQ: whether having clinical diagnosis/clinical levels of symptoms negatively impacts early language development (expressive vocabulary size). Model 1 treated groups as categorical factors: risk vs. no-risk based on whether

**Table 1.** Means and standard deviations for depression (CESD-R), anxiety (STAI), vocabulary (OZI), MLU, word token, and types by age and group

Child age (months)	Risk	CESD-R		STAI		OZI	
		Mean	SD	Mean	SD	Mean	SD
24	Control	4.67	7.00	32.60	6.54	271.67	127.98
	Risk	9.80	9.83	34.80	7.69	253.77	137.11
30	Control	2.38	2.97	28.75	5.55	434.14	95.61
	Risk	7.55	6.65	33.55	10.22	476.75	94.26
Child age (months)	Risk	MLU		Token		Type	
		Mean	SD	Mean	SD	Mean	SD
24	Control	4.62	0.78	864.64	291.39	185.57	55.72
	Risk	4.42	0.82	645.64	246.51	156.18	48.00
30	Control	5.25	0.70	843.63	239.77	194.13	31.89
	Risk	4.56	0.91	625.17	254.15	165.50	48.24

mothers did or did not have a diagnosis of depression or anxiety and/or had elevated symptoms. Model 2 did not include a group comparison but instead treated the depression and anxiety scores as continuous variables. Both models included the same mother-child dyads.

In Model 1, children's OZI scores were entered as the dependent variable and ages (24 vs. 30 months) and group (risk vs. no-risk) as fixed factors with interaction. MLU, word token, and type were entered as covariates, and participants were entered as a random variable with random intercepts (see Table 2 for results). The model detected the main effect of age and MLU, with no other significant effects detected. The main effect of age suggests that both groups showed an increase in OZI scores between 24 and 30 months ( $M_{24} = 263$  vs.  $M_{30} = 457$ ), and the main effect of MLU suggests that increases in MLU predicted increases in OZI scores.

The second model addressed our second RQ about timing: whether having concurrent higher levels of symptoms negatively impacts language development (expressive vocabulary size). Model 2 included children's OZI scores as the dependent variable, ages (24 vs. 30 months) as a categorical factor, and STAI, CESD-R, MLU, word type, and token as continuous covariates and participants entered as a random variable with random intercepts (see Table 3 for results). The model detected a main effect of age, MLU, word token, and type, with no other significant effects detected. The main effects of age and MLU are consistent with Model 1, but with the addition of anxiety and depression scores as continuous variables, both word type and token significantly predicted OZI scores. The significant word token and type effects suggest that decreasing tokens and increasing types predicted increases in OZI scores. These results suggest that child vocabulary development is predicted by increasing the use of word diversity (type) and decreasing the use of word repetition (token) in the third year of development.

A correlation analysis using Pearson's  $r$  at 24 and 30 months was conducted to explore any possible correlation among the predictors (see Supplementary Materials S2). Significant moderate positive correlations were detected between STAI and CESD-R (anxiety

**Table 2.** Model 1 fixed-effects parameter estimates

Names	Estimate	SE	95% CI		df	t	p
			Lower	Upper			
(Intercept)	348.121	18.627	311.614	384.629	24.300	18.689	< .001***
Group (risk vs. control)	22.935	39.637	-54.751	100.622	27.100	0.579	0.568
Age (24 vs 30)	161.120	28.510	105.241	216.998	20.500	5.651	< .001***
MLU	62.546	21.728	19.960	105.132	30.700	2.879	0.007**
Word token	-0.155	0.131	-0.411	0.101	26.200	-1.185	0.247
Word type	0.890	0.717	-0.515	2.295	30.800	1.242	0.224
Group x age	80.134	54.749	-27.172	187.440	18.600	1.464	0.160

R-code: OZI ~ 1 + Age + Group + MLU + WordToken + WordType + Risk:Child\_Age + (1 | Participant).

\*\* $p < .01$ ,

\*\*\* $p < .001$

**Table 3.** Fixed-effects parameter estimates

Names	Estimate	SE	95% CI		df	t	p
			Lower	Upper			
(Intercept)	127.819	93.330	-55.104	310.742	22.800	1.370	0.184
Age (24 vs. 30)	149.331	27.209	96.003	202.659	13.300	5.488	< .001***
CESD-R	0.467	1.479	-2.432	3.365	23.500	0.316	0.755
STAI	-0.900	1.764	-4.356	2.557	24.800	-0.510	0.614
MLU	47.682	19.686	9.098	86.267	22.100	2.422	0.024*
Word token	-0.280	0.113	-0.502	-0.058	18.200	-2.469	0.024*
Word type	1.843	0.667	0.536	3.150	24.700	2.764	0.011*

R-code: OZI ~ 1 + Age + MLU + STAI + CESD-R + WordToken + WordType +(1 | Participant).

\* $p < .05$ ,

\*\*\* $p < .001$

and depression symptoms) at both 24 and 30 months – this is consistent with past research (Brookman et al., 2020a, b; Dol et al., 2022). Significant moderate negative correlations were also detected for CESD-R with MLU at 24 months and with token at 30 months. Significant moderate negative correlations were detected between MLU and Type at both 24 and 30 months, and significant strong positive correlations were detected between type and token at both 24 and 30 months.

## Discussion

We found no support for our main hypotheses. The analyses did not detect clinical status (history of clinical diagnosis/elevated symptoms) or timing (concurrent levels of depression and anxiety symptoms) as significant predictors of vocabulary size in children during

the third year of life. However, maternal input measures, especially MLU, did predict vocabulary size at 24 and 30 months, and the effect is similar for children with mothers who did vs. did not experience (*historical or concurrent*) clinical levels of depression and/or anxiety symptoms during early development. These findings suggest that children's vocabulary size increased between 24 and 30 months, and maternal depression and anxiety did not play a direct role in vocabulary development in our community sample<sup>2</sup>.

Our results suggest that maternal input measures, especially complexity of the input, continue to be strong predictors of vocabulary development during the third year of life for both children of mothers with and without a clinical diagnosis/elevated depression and/or anxiety symptoms. The complexity of the language input, as measured by MLU, consistently predicted vocabulary size across development at 24 to 30 months. Quantity and diversity (token and type) of words in the maternal input were the only significant predictors of vocabulary development when the entire sample was treated as a single group (with depression and anxiety scores as continuous variables). This suggests that MLU may be a more sensitive measure. Overall, our results show that vocabulary development in 2-year-olds was predicted by a decrease in word tokens and an increase in word types and general complexity of the linguistic model (MLU). This suggests that mothers are using more diverse vocabulary and complex language while reducing word repetitions as children develop larger vocabularies – consistent with previous studies with typically developing 2-year-olds (Hoff & Naigles, 2002). This finding, together with Brookman *et al.* (2020a, 2023), echoes the importance of mothers speaking to their infants as much as possible over the first two years of development to kick start the language learning process, but by the third year, mothers are using more diverse vocabulary and increasing the complexity of their language model.

The lack of any difference in vocabulary size between groups is consistent with our previous findings with this longitudinal cohort (Brookman *et al.*, 2020a, 2023) and may suggest that good management of clinical symptoms during early development can protect against poor language development. Those studies found that the effect of depression and anxiety symptoms during the first year of life on vocabulary development at 18 months was moderated by maternal input – conversational turns and maternal responsiveness. Our current findings also suggest similar direct effects of depression and anxiety symptoms on vocabulary. While neither depression nor anxiety predicted vocabulary development, correlations were detected between depression and maternal input. Mothers with higher depression symptoms produced shorter and less complex sentences (smaller MLUs) and fewer words (tokens). The correlation found between depression and anxiety means that we cannot tease apart their independent effects. Therefore, the current findings are consistent with past reports that depression and anxiety symptoms exert an indirect effect on vocabulary development through maternal input, highlighting the importance of social facilitation in language development. Similar significant findings with depression as a moderating effect have been reported, but this is by no means a consistent finding (see Clifford *et al.*, 2024, for a broader discussion). The different focus across studies on various ages of children, length of depression, the timing of symptoms, and diagnosis makes concluding studies challenging. However, given that our risk sample did not report prolonged elevated clinical levels of depression over the entire duration of the study, our findings do suggest that good clinical management of maternal depression and anxiety symptoms is

<sup>2</sup>Future studies with larger samples are needed to rule out the possibility that this study is underpowered.



beneficial to children's language development – consistent with the findings of the recent systematic review (Clifford et al., 2024).

Related to the above point, some caution must be taken when generalising the results of our community sample to the larger clinical population. First, during the course of our longitudinal study, and especially after the first year of life, nearly all mothers in our sample reported subclinical levels of depression and anxiety, i.e., only reporting elevated clinical levels at a few sampling points. This could reflect different developmental phases where acute postnatal depression subsides into the second and third years of life with time, or it could reflect good clinical management in our sample. This is especially likely given the generally high maternal education levels of this sample and, therefore, higher SES. Second, the number of mothers returning to the study at 24 and 30 months was reduced as most returned to full-time employment. Therefore, the effect of depression and anxiety symptoms may not be detectable in the current sample but may be present in the larger clinical population. For example, our results should not be generalised to mothers with continued elevated clinical levels of depression and anxiety symptoms throughout their children's early development. The sustained effect of elevated clinical levels of symptoms could not be evaluated by this study. Despite the need for more studies, especially those with longitudinal data, to more effectively evaluate the impact of clinical status and timing on child language development, our study does highlight the critical importance of early and continued management of symptoms during early development for language outcomes. Our results, together with the recent systematic review (Clifford et al., 2024), suggest that short periods of clinical levels of maternal depression and anxiety symptoms during early development may not have lasting effects on children's language development, especially if high-quality maternal input in both quantity and quality can be maintained.

One point of difference in the findings among our longitudinal sample is the effect of depression and anxiety on vocabulary size vs. word processing. While the current study together with Brookman et al. (2020a) and (2023) reported no group differences for vocabulary size at 18, 24, and 30 months, Brookman et al. (2020b) found that children in the risk group were slower to process words in a lexical identification task at 18 months. Therefore, it is possible that the vocabulary measure used here is not sensitive enough to capture more fine-grained differences in, e.g., how robustly words are encoded, represented, and/or retrieved during online processing for at-risk children. While caregiver vocabulary reports are time efficient in evaluating children's linguistic knowledge, they are not designed to evaluate children's language processing skills. The cumulative effect of slower word (and sentence) processing can have profound impacts on children's social and academic outcomes. Future studies should further probe these linguistically dependent cognitive processes as a function of development to fully understand the impact of early exposure to risk factors on later development so that we can better prepare and support at-risk children as they enter schools.

Two additional limitations should be considered when interpreting the results of this study. First, only mothers were included in the assessments as children's primary caregivers. However, it is the case that more fathers become primary carers or take on equal caring responsibilities, and their role in children's language development should be considered (see Ferjan Ramírez, 2022, for a discussion on language input from fathers versus mothers). However, the finding that good mental health management may be critical in ensuring good early language development should also extend to fathers and others responsible for the primary care of infants. Second, the majority of our sample have a graduate degree or higher, which could lead to better access to mental healthcare. Our

findings have important implications for families with lower socioeconomic status and government policies. Mental health services must be delivered to all mothers in need of support in a timely fashion in response to the narrow early child developmental window.

## Conclusion

In a community sample, we found that maternal emotional health concerns did not predict poorer vocabulary outcomes in 2-year-olds. Our results suggest that good management of maternal depression and anxiety symptoms, as well as providing a language model with increasing complexity as children's language develops, are critical during early development. Our series of longitudinal studies together suggest that continued clinical management of depression and anxiety symptoms from birth is critical in reducing the risk of poor language development in young children. These studies also call for future longitudinal studies to track development beyond the first 3 years of life and examine the impact of depression and anxiety on later language and literacy development.

**Supplementary material.** The supplementary material for this article can be found at <http://doi.org/10.1017/S0305000924000308>.

## References

- Barlow, D. H.** (2004). *Anxiety and its disorders: The nature and treatment of anxiety and panic*. Guilford Press.
- Brookman, R., Kalashnikova, M., Conti, J., Xu Rattanasone, N., Grant, K. A., Demuth, K., & Burnham, D.** (2020a). Depression and anxiety in the postnatal period: An examination of infants' home language environment, vocalisations, and expressive language abilities. *Child Development*, *91*(6), e1211–e1230.
- Brookman, R., Kalashnikova, M., Conti, J., Xu Rattanasone, N., Grant, K. A., Demuth, K., & Burnham, D.** (2020b). Maternal depression affects infants' lexical processing abilities in the second year of life. *Brain Sciences*, *10*(12), 977.
- Brookman, R., Kalashnikova, M., Conti, J., Levickis, P., Xu Rattanasone, N., Grant, K. A., Demuth, K., & Burnham, D.** (2023). Postnatal depression; Maternal responsiveness; infancy, language development; vocabulary size; Mother-infant interactions, anxiety. *PLOS ONE*, *18*(1), e0277762.
- Campbell, S. B., Matestic, P., von Stauffenberg, C., Mohan, R., & Kirchner, T.** (2007). Trajectories of maternal depressive symptoms, maternal sensitivity, and children's functioning at school entry. *Developmental Psychology*, *43*(5), 1202.
- Clifford, B. N., Stockdale, L. A., Coyne, S. M., Rainey, V., & Benitez, V. L.** (2022). Speaking of state of mind: Maternal mental health predicts children's home language environment and expressive language. *Journal of Child Language*, *49*(3), 469–485.
- Clifford, B. N., Rainey, V., & Eggum, N. D.** (2024). Parental postpartum depression and children's receptive and expressive language during the first six years of life: A systematic review of depression timing, status, and chronicity. *Developmental Review*, *71*, 101105.
- Diagnostic and statistical manual of mental disorders: DSM-5-TR** (5th ed., text revision). (2022). Washington, DC: American Psychiatric Association Publishing.
- Dol, M., McDonald, E., & Ferro, M. A.** (2022). Psychometric properties of the CESD, STAI-T, and PSS among parents of children with mental illness. *Journal of Family Studies*, *28*(4), 1416–1432.
- Eaton, W. W., Smith, C., Ybarra, M., Muntaner, C., & Tien, A.** (2004). Center for Epidemiologic Studies Depression Scale: Review and revision (CESD and CESD-R).
- Engle, P. L.** (2009). Maternal mental health: Program and policy implications. *The American Journal of Clinical Nutrition*, *89*(3), 963S–966S.
- Farr, S. L., Dietz, P. M., O'Hara, M. W., Burley, K., & Ko, J. Y.** (2014). Postpartum anxiety and comorbid depression in a population-based sample of women. *Journal of Women's Health*, *23*, 120–128.

- Fenson, L. (2007). *MacArthur-Bates communicative development inventories*. Baltimore, MD: Paul H. Brookes Publishing Company.
- Ferjan Ramirez, N. (2022). Fathers' infant-directed speech and its effects on child language development. *Language and Linguistics Compass*, **16**(1), e12448.
- Gallucci, M. (2019). *GAMLj: General analyses for linear models*. [jamovi module]. <https://gamlj.github.io/>.
- Gavin, N. I., Gaynes, B. N., Lohr, K. N., Meltzer-Brody, S., Gartlehner, G., & Swinson, T. (2005). Perinatal depression: A systematic review of prevalence and incidence. *Obstetrics & Gynecology*, **106**(5 Part 1), 1071–1083.
- Glasheen, C., Richardson, G. A., & Fabio, A. (2010). A systematic review of the effects of postnatal maternal anxiety on children. *Archives of Women's Mental Health*, **13**(1), 61–74.
- Grant, K. A., McMahon, C., & Austin, M. P. (2008). Maternal anxiety during the transition to parenthood: A prospective study. *Journal of Affective Disorders*, **108**(1–2), 101–111.
- Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Paul H Brookes Publishing.
- Hoff, E., & Naigles, L. (2002). How children use input to acquire a lexicon. *Child Development*, **73**(2), 418–433.
- Jones, G., & Rowland, C. F. (2017). Diversity not quantity in caregiver speech: Using computational modeling to isolate the effects of the quantity and the diversity of the input on vocabulary growth. *Cognitive Psychology*, **98**, 1–21.
- Kaitz, M., Maytal, H. R., Devor, N., Bergman, L., & Mankuta, D. (2010). Maternal anxiety, mother–infant interactions, and infants' response to challenge. *Infant Behavior and Development*, **33**(2), 136–148.
- Kalashnikova, M., Schwarz, I. C., & Burnham, D. (2016). OZI: Australian English communicative development inventory. *First Language*, **36**(4), 407–427.
- Kaplan, P. S., Danko, C. M., Everhart, K. D., Diaz, A., Asherin, R. M., Vogeli, J. M., & Fekri, S. M. (2014). Maternal depression and expressive communication in one-year-old infants. *Infant Behavior and Development*, **37**, 398–405.
- Kuhl, P. K. (2007). Is speech learning “gated” by the social brain? *Developmental Science*, **10**, 110–120.
- Leach, L. S., Poyser, C., & Fairweather-Schmidt, K. (2017). Maternal perinatal anxiety: A review of prevalence and correlates. *Clinical Psychologist*, **21**(1), 4–19.
- MacWhinney, B. (2000). *The CHILDES project: Tools for analysing talk*. 3rd ed. Mahwah, NJ: Lawrence Erlbaum Associates
- Matthey, S., Barnett, B., Howie, P., & Kavanagh, D. J. (2003). Diagnosing postpartum depression in mothers and fathers: Whatever happened to anxiety? *Journal of Affective Disorders*, **74**, 139–147.
- Murray, L., Halligan, S., & Cooper, P. (2010). Effects of postnatal depression on mother–infant interactions, and child development. *The Wiley-Blackwell handbook of infant development*, **2**, 192–220.
- Nicol-Harper R, Harvey AG, Stein A. (2007). Interactions between mothers and infants: Impact of maternal anxiety. *Infant Behavior & Development* **30**(1):161–167.
- Pace, A., Alper, R., Burchinal, M. R., Golinkoff, R. M., & Hirsh-Pasek, K. (2019). Measuring success: Within and cross-domain predictors of academic and social trajectories in elementary school. *Early Childhood Research Quarterly*, **46**, 112–125.
- R Core Team (2021). *R: A language and environment for statistical computing* (Version 4.0) [Computer software]. <https://cran.r-project.org>. (R packages retrieved from MRAN snapshot 2021-04-01).
- Reck, C., Noe, D., Gerstenlauer, J., & Stehle, E. (2012). Effects of postpartum anxiety disorders and depression on maternal self-confidence. *Infant Behavior and Development*, **35**, 264–272.
- Reck, C., Tietz, A., Müller, M., Seibold, K., & Tronick, E. (2018). The impact of maternal anxiety disorder on mother–infant interaction in the postpartum period. *PloS One*, **13**(5), e0194763.
- Reck, C., Van Den Bergh, B., Tietz, A., Müller, M., Ropeter, A., Zipser, B., & Pauen, S. (2018). Maternal avoidance, anxiety cognitions and interactive behaviour predicts infant development at 12 months in the context of anxiety disorders in the postpartum period. *Infant Behavior and Development*, **50**, 116–131.
- Rowe, M. L. (2012). A longitudinal investigation of the role of quantity and quality of child-directed speech in vocabulary development. *Child Development*, **83**(5), 1762–1774.
- Scheiber, F. A., Ryckman, K. K., & Demir-Lira, Ö. E. (2022). Maternal depressive symptoms and maternal child-directed speech: A systematic review. *Journal of Affective Disorders*, **297**, 194–207.

- Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A.** (1983). *Manual for the state-trait anxiety inventory* Palo Alto, CA: Spielberger.
- The Jamovi Project** (2021). *jamovi*. (Version 1.8) [Computer Software]. <https://www.jamovi.org>.
- Van Dam, N. T., & Earleywine, M.** (2011). Validation of the Center for Epidemiologic Studies Depression Scale—Revised (CESD-R): Pragmatic depression assessment in the general population. *Psychiatry Research*, **186**(1), 128–132.

---

**Cite this article:** Xu Rattanasone, N., Brookman, R., Kalashnikova, M., Grant, K.-A., Burnham, D., & Demuth, K. (2024). Maternal input, not transient elevated depression and anxiety symptoms, predicts 2-year-olds' vocabulary development. *Journal of Child Language* 1–12, <https://doi.org/10.1017/S0305000924000308>