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Is prenatal maternal mental problem associated with offspring's language skills at two years old?

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Abstract

The current study examined the impact of prenatal maternal anxiety on toddlers' language development at two years old. Maternal anxiety status of 48, 36 and 32 pregnant women was evaluated using a validated questionnaire during pregnancy at the first, second and third trimesters respectively. Mothers were grouped into anxious and non-anxious groups according to the clinical cut-off. Two year postpartum anxiety level of all the mothers was obtained as a covariate. Children's language abilities were assessed using the Cantonese version of the MacArthur Communicative Development Inventory (CCDI). Results showed that there was no significant difference between the language scores reported in the prenatally "anxious" and "non-anxious" groups in all three trimesters after controlling for the 2-year postpartum anxiety level. The results implied that effect of prenatal maternal stress is not associated with children's language functioning. Language acquisition is a complex process influenced by multiple factors. This study highlighted some methodological considerations when conducting similar kind of study.

Specific language impairment (SLI) is diagnosed using mainly exclusionary criteria: significant language delay without evidence of alternative explanatory factors including hearing impairment, cognitive dysfunctions, social-affective disorders as well as other neurological and organic anomalies (Leonard, 1998). The use of exclusionary criteria is not only due to the enormous heterogeneity of this clinical group but also its unclear etiology. Growing number of neuroimaging studies performed on children with SLI showed the evidence that SLI does reflect certain levels of underlying brain dysfunction (Lane, Foundas, & Leonard, 2001; Gauger, Lombardino, & Leonard, 1997). More recent study pointed to the disrupted brain function or abnormal brain morphology in the population with language disorders. The association between SLI and atypical brain morphology was evident by a recent study investigating the cranial activity of children with SLI using functional magnetic resonance imaging (MRI) scan (De Guibert et al., 2011). Children with SLI showed a significantly impoverished left lateralization and diminished activity level in all core language areas (superior temporal gyrus, supramarginal gyrus, inferior frontal gyrus-triangularis and inferior frontal gyrus-opercularis) in all four language tasks, when compared with their age-matched typical peers. These atypical cranial findings might suggest some potential brain alterations in children with SLI. However, very little is known about what causes these variations in the brain function.

Genetic Contribution

An aggregating body of research evidence has pointed to the potential contribution of genetic inheritance. Leonard (1998) reviewed a number of familial aggregation studies (Neils & Aram, 1986; Tallal, Ross, & Curtiss, 1989; Tomblin, 1989) and twin studies (Bishop, 1992; Lewis & Thompson, 1992; Tomblin & Buckwalter, 1994), and revealed a strong genetic basis in SLI. More direct evidence comes from a recent molecular genetic study that identified the major susceptible genes for SLI. For example, using nonword repetition skills

as an outcome measure, research identified the chromosomal region of 16q24 is related to SLI while using expressive language impairment as the outcome measure, the region of 19q13 was identified (SLI Consortium, 2009). Some studies have investigated the genetic influence on brain morphology through genetic brain maps and multivariate genetic analyses (Posthuma et al., 2000; Schmitt et al., 2008; Thompson et al., 2001). Researchers have reported that brain size, cortical thickness and gray matter volume are moderately controlled by genetics. These studies made use of twin design by comparing the brain structures of singleton siblings and twins. However, a dearth of studies examined the link between brain abnormalities and genetic contribution of SLI. One twin study has demonstrated an unbalanced lateralization of parieto-temporal grey matter heterotopias in both monozygotic twins at nine years of age with language impairment and more pronounced in the more affected twin (Peris, Engelbrecht, Huang, & Steinmetz, 1998). Researchers attempted to trace the origin back to the genetic level.

Epigenetic Factors

The incomplete penetrance (concordance rate less than 100%) of SLI in monozygotic twins, however, implies that genetic factor does not provide a satisfactory explanation. While twin studies can provide strong evidence of genetic inheritance on brain structure, cranial alterations could be induced by numerous nongenetic factors. “Epigenetic” factors can be one of them and provided fruitful account to previous findings from familial and twin studies and also brain abnormality revealed in many neuro-developmental disorders. These factors can modify or change gene expressions which can override genetic inheritance (Petronis, 2001).

In recent years, sizeable studies had proposed the contribution of heightened prenatal maternal stress hormones (cortisol) as an epigenetic factor to the development of fetal brain. During pregnancy, women are often subject to major emotional stress which could be induced by stressful life events or other environmental stressors such as financial burden

(Faisal-Cury & Rossi Menezes, 2007). In response to the increased prenatal stress level, major maternal physiological changes would take place. Upon acute stress, the Hypothalamic–Pituitary–Adrenal (HPA) Axis and the Autonomic Nervous System (ANS) will be activated, inducing an elevated secretion of cortisol into maternal circulation which may further enter fetal neonatal circuits through the placenta (Miller & O'Callaghan, 2002). Gitau et al. (1998) and Gitau et al. (2001) investigated the relationship between maternal and fetal cortisol levels and indicated a moderately strong positive correlation, suggesting that increased maternal cortisol levels will lead to increased cortisol level in the fetus. The detrimental effects of heightened levels of cortisol on fetus brain development had already been well documented. Buss, Davis, Muftuler, Head and Sandman (2010) studied the changes in brain morphology in response to prenatal maternal stress in children aged between six and nine years old using MRI scan. The pregnancy specific anxiety level was measured using a 10-item reliable pregnancy anxiety scale, which was specifically developed for pregnancy research (Rini, Dunkel-Schetter, Wadhwa, & Sandman, 1999; Glynn, Schetter, Hibel, & Sandman, 2008). Their study attested that elevated maternal cortisol and subsequent transplacental passage of cortisol to fetus is detrimental to fetus brain development, in terms of the reductions in volume of gray matter.

Given the potential underlying cause of brain abnormalities in SLI and the brain abnormality induced by prenatal stress (Gauger, Lombardino, & Leonard, 1997), it is reasonable to speculate that prenatal mental problems can be a risk factor of SLI. The present study aimed to explore the association between prenatal mental health problem and offspring's language functioning at the age of two.

Prenatal Mental Health Problem and Offspring's Language Development

A systematic review (Field, Diego, & Hernandez-Reif, 2006) revealed that there is a substantial body of scientific evidence pointing to the negative consequences of prenatal

stress on neonatal growth including prematurity, low birth weight and inferior motor skills. Studies investigating the consequences of prenatal stress on toddlers' cognitive and language functioning had also been emerging but mixed findings were reported.

Laplante et al. (2004) carried out a prospective longitudinal study investigating the impact of prenatal maternal stress induced by natural disasters on toddlers' cognitive and language development. In their study, the language abilities of 58 toddlers whose mothers had experienced different levels of prenatal stress at different trimesters of gestation that is, first trimester (1-3 months), second trimester (4-6 months) and third trimester (6-9 months) in an ice storm were evaluated by the MacArthur Communicative Development Inventory (MCDI) (Fenson et al., 1993). The maternal psychological stress was estimated in both an objective and subjective manner, which were measured by investigating the mothers' responses to questions about their threat, loss, change and scope during the disaster and a widely used assessment tool for trauma-related distress respectively. When toddlers' birth weight and age at testing were controlled, prenatal stress defined objectively uniquely accounted for 12.1% of the child's language functioning. However, such strong association was not observed for subjectively defined stress. Specific timing effect for the exposure of prenatal stressors on language outcomes was also not detected. Although maternal postnatal depression was measured in this study, it was not considered as one of the controlling variables, disregard of its potential effect on infant development.

Some mixed results have been reported in more recent studies (DiPietro, Novak, Costigan, Atella, & Reusing, 2006; Davis & Sandman, 2011). In a prospective cohort consisting of 94 mother-child dyads (DiPietro, Novak, Costigan, Atella, & Reusing, 2006), the association between maternal stress during pregnancy and toddlers' general cognitive functioning including language development was studied. Maternal psychological distress in terms of anxiety, depression, pregnancy specific stress and non-pregnancy specific stress

were measured all by validated psychological assessments. Developmental functioning of the children at age 2 was estimated by means of the Mental Scale of the Bayley Scales of Infant Development (BSID) (1993) which assesses a child's fine- and gross motor skills, expressive and receptive language ability as well as cognitive ability. From their findings, Bayley Mental Developmental Index (MDI) scores were significantly and *positively* associated with prenatal anxiety, depression and non-pregnancy specific stress after controlling for postnatal stress. That means, children born to mothers who experienced more anxiety, depression and non-pregnancy specific stress during pregnancy were more likely to perform better in the Bayley MDI. However, maternal psychological status was only measured in mid-gestation (i.e. 24, 28 or 32 weeks gestation), without investigating the impact of maternal stress in early and late gestation. Similar facilitative effect of prenatal stress on fetal cognitive development was also observed in another study and momentous effect on the timing of exposure to stressors was found (Davis & Sandman, 2011). In their study, 125 mother-child dyads were recruited to examine their maternal stress and infant cognitive development. Unlike the previous two mentioned studies, maternal stress hormone (cortisol) was measured using salivary cortisol assessment, in addition to the validated maternal psychological assessments on anxiety, perceived stress, pregnancy specific anxiety and depression at five intervals during pregnancy (i.e. 15, 19, 25, 31 and 37 weeks gestation) as well as at 3, 6 and 12 months postpartum. Similarly, toddlers' cognitive abilities were also measured by means of BSID. Results indicated that maternal stress that occurred at distinct trimesters would result in very different infant developmental outcomes. Cognitive functioning of toddlers at one year old was decreased with increased levels of maternal cortisol level in early gestation (i.e., at 15 weeks). On the contrary, higher maternal cortisol level in late gestation (i.e., at 37 weeks), predicted enhanced mental development of toddlers. Meanwhile, *high* pregnancy specific anxiety during *early* gestation and a large reduction in pregnancy specific anxiety through

mid gestation accounted for lower MDI scores. However, such association was not shown for all other non-pregnancy specific maternal psychological measures. For all these associations, potential covariates including postnatal maternal stress have been controlled.

Despite the numerous research evidence pointing to the plausible etiological role of prenatal mental problems in SLI, in the field of speech and language pathology, very few studies regard prenatal stress as a risk factor. As reported in a recent systematic review examining the risk and protective factors of speech and language impairment for language impairment (Harrison & McLeod, 2010), child, parent, family as well as community variables were included. However, such review did not locate any study about prenatal mental effect on children's language ability.

Aim of the Present Study

This present study aims at investigating the association between prenatal mental problem and the offsprings' language problems in the toddler years, after controlling for potential confounding factor of postnatal maternal health problems. To be more specific, the following two research questions will be addressed in the present study:

1. Is prenatal maternal mental problem associated with offspring's language skills at two years old?
2. Does toddlers' language functioning respond differently towards maternal stressors at different trimesters?

Methodology

Participants

Study participants were recruited according to a registry developed for a previous study investigating the role of antenatal stress in obstetric complications by (Lee, Lam, Lau, Chong, Chui, & Fong, 2007). Pregnant women were recruited from antenatal clinics of the Queen Mary Hospital and Tsan Yuk Hospital in Hong Kong and were followed

longitudinally from early gestation to late gestation and 24 months postpartum. Eligible participants were Cantonese-speaking women who were over 18 years old. Exclusionary criteria include in-vitro fertilization, diabetes mellitus, significant medical diseases and consideration of pregnancy termination. For the current study, recruitment was also restricted to children aged between 20 months to 27 months at the time of testing and with full term gestation. Based on these criteria, suitable parents were invited to participate in the present study. Three of the original 54 participants were retrospectively excluded due to preterm delivery and one participant was excluded due to missing data, remaining the current 50 eligible healthy toddlers (34 girls and 16 boys, *M* age = 24.4 months, *SD* = 1.2 months) without obstetric complications born at term to participate in the study. The specific number of participants with available data for maternal psychological measures at the first, second and third trimesters (12, 20 and 36 weeks of gestation) are presented in Table 1. Postpartum anxiety level was also collected for all the mothers. Variations in the number of participants at different assessment periods were due to incomplete responses on the maternal psychological measure.

Table 1

Number of Participants for Maternal Psychological Measure at Different Assessment Periods

Psychological Measure	Number of Participants		
	First Trimester	Second Trimester	Third Trimester
HADS	48	36	32

HADS=Hospital Anxiety and Depression Scale

Procedures

Potentially eligible mothers in the current database were invited to participate in the current study through initial phone calls. Home visits or visits to the Division of Speech and Hearing Sciences, the University of Hong Kong were arranged to have face-to-face

interviews with mothers who were willing to participate. Women were given written informed consent about the participation in the study which had been approved by the Faculty Research Ethics Committee at the University of Hong Kong.

During the visit, written consents were obtained and the mothers were interviewed about the toddlers' language skills using the short form of a Cantonese version of the MacArthur Communicative Development Inventory: Words and Sentences (CCDI: WS, Tardif, Fletcher, Zhang, & Liang, 2008) (see below). The form included major components of 134-item vocabulary checklist. The mothers were also asked to fill out the Chinese version of Anxiety Subscale of Hospital Anxiety and Depression Scale (HADS, Zigmond & Snaith, 1983) (see below). The interview lasted for about 20 to 30 minutes. Investigator interviewing the parents was blind to the maternal stress status and all other covariates to minimize observer bias.

Maternal Psychological Measure

The mental health status of the mothers was assessed using a validated questionnaire, the Anxiety subscale of HADS (Zigmond & Snaith, 1983), for their anxiety level upon their scheduled visit during their pregnancy at the antenatal clinic of the Queen Mary Hospital and Tsan Yuk Hospital in Hong Kong starting from early pregnancy. Assessments were administered at the first, second and third trimesters (12, 24 and 36 weeks of gestation). The maternal anxiety status was reassessed at 24 months postpartum. Assessment on maternal prenatal anxiety level was done using the Anxiety Subscale of HADS in Chinese –Cantonese Version (Zigmond & Snaith, 1983), which is a widely used reliable tool for assessing emotional states of anxiety. The Chinese version was found to have satisfactory agreement with the original English version (Leung, Ho, Kan, Hung & Chen, 1993) and was demonstrated to have high sensitivity and specificity for identifying psychiatric disorders (Leung, Wing, Kwong, Lo, & Shum, 1999). The original scale is a self-rating questionnaire

consisting of 7 questions relevant to anxiety. The participants were asked to rate on a 4-point scale (0-3) for each of the 7 items, adding up a total maximum score of 21 with higher scores indicating a higher anxiety level. Mothers having scores above the established cut-off of 7 were screened as having significant anxiety (Snaith, 2003).

Child's Language Measure

The Cantonese version of the MacArthur Communicative Development Inventory (CCDI) (Tardif, Fletcher, Zhang & Liang, 2008) was administered to assess the toddlers' productive language skills shortly after their second birthday. CCDI is a standardized and validated parental report measure for assessing toddlers' early language abilities. It is a reliable and valid instrument that evaluates Cantonese-speaking toddlers' language development from the expansion of early vocabulary to early syntax. The short form of the CCDI: Words and Sentences (CCDI: WS) with the norm spanned from 16 months to 30 months was adopted to explore the toddlers' inventory of expressive language. The CCDI: WS contains a vocabulary checklist with 134 items and the mothers were required to complete the inventory by indicating which of the listed words their children could produce spontaneously. Children's CCDI productive language scores were calculated by adding up the total number of vocabulary produced as the raw score. Their corresponding productive language percentiles were then estimated by comparing their raw scores against their respective ages as the outcome measures.

Confounding Variable

Postpartum maternal anxiety level was included as a covariate due to its strong association with children's language impairment (La Paro, Justice, Skibbe, & Pianta, 2004). Postnatal anxiety levels were measured at 24 months postpartum using the Anxiety subscale of HADS.

Statistical Analysis

Toddlers' CCDI productive language percentiles of the two groups of mothers above and below the clinical cutoff for anxiety on the HADS scale at the first, second and third trimesters were compared. Descriptive statistics in terms of means and standard deviations of children's language outcomes with referent to the independent variable were calculated. Univariate analysis of covariance (ANCOVA) was used to investigate if significant differences in CCDI productive language scores existed between anxious and non-anxious groups. Postpartum scores from the Anxiety subscale of HADS were entered as a covariate to control for their potential contributions to the existing group differences.

Results

Table 2 summarizes the descriptive statistics showing the means and standard deviations of the child's CCDI productive language percentiles in the anxious and non-anxious group at the three trimesters. On average, the toddlers' CCDI productive language percentiles were close to the mean percentile (50%) within the normal population. The CCDI productive language percentiles were observed to be higher for the prenatally anxious group than the non-anxious group at all the three trimesters while bigger differences were observed at the third trimester.

Table 2

Descriptive Statistics of CCDI Productive Language Percentiles for Prenatal Anxiety at Each Trimester

	Anxiety		No anxiety	
	n	*M (SD)*	*n*	*M (SD)*
First Trimester	7	47.0 (31.7)	41	44.8 (27.2)
Second Trimester	6	53.2 (30.5)	30	50.8 (29.8)
Third Trimester	18	62.7 (28.3)	14	44.2 (24.6)

Homogeneity of variance between groups was tested using the Levene's test. The variances were not significantly different for all the three trimesters even though the number of participants differed between the two groups (First trimester: $F(1, 46) = .160$, $p = .691$; second trimester: $F(1, 34) = .157$, $p = .694$; third trimester: $F(1, 30) = .637$, $p = .431$). Therefore, the assumption on homogeneity of variance was held and ANCOVA could be performed. Univariate ANCOVA with 24-month postpartum anxiety level as covariate was carried out to compare the CCDI productive language percentiles between the anxious and non-anxious groups at the three trimesters. Scores of the Anxiety subscale of HADS at 24 months postpartum were entered as a covariate to control for its potential effect on the group differences. Results are summarized in Table 3. The anxious and non-anxious groups did not differ significantly in any of the trimester.

Table 3

Group Differences in CCDI Productive Language Percentiles at Each Trimester after Controlling for Postpartum Anxiety

	Anxiety		No anxiety				
	n	*M (SD)*	*n*	*M (SD)*	*F*	*p*	η^2
First Trimester	7	47.0 (31.7)	41	44.8 (27.2)	.023	.880	.001
Second Trimester	6	53.2 (30.5)	30	50.8 (29.8)	.026	.873	.001
Third Trimester	18	62.7 (28.3)	14	44.2 (24.6)	3.536	.070	.109

Discussion

The present study found that maternal anxiety levels at trimesters one, two and three were not associated with toddlers' language outcomes even after controlling for the 24-month postpartum anxiety level. The present study cannot replicate the findings from previous studies that indicated an association between prenatal maternal psychological stress and offspring's language functioning. For example, as reviewed above, Laplante et al. (2004)

reported a significant negative association between objectively defined prenatal stress and infant language development. Such discrepancies in research findings between the present study and Laplante et al. (2004) might be explained by the different maternal stress measures and the inclusion of confounding variables in thee two studies. In the study by Laplante et al. (2004), the researchers made use of two measures for maternal stress, subjective and objective measures. Subjective stress was measured using the Impact of Event Scale-Revised (IES-R) (Weiss & Marmar, 1997), a self-rating psychological scale for assessing distress after trauma while objective stress was estimated using the mothers' responses towards questions about loss, scope, threat and change caused by the natural disaster. Laplante and his colleagues (2004) did not find any significant association between subjective prenatal stress and the children's language outcome. Their conclusion on the existence of significant negative association was drawn based on objective maternal stress. However, objectively defined maternal stress might not be able to truly reflect maternal psychological states. Deviant psychological responses might be induced even when people are subject to the same kind of stressors due to individual differences (Pearlin, 1982). Anderson (1977) suggested such individual differences could be due to different types of locus of control. People with internal locus of control would perceive less stress than externals when they were exposed to the same natural disaster as they perceive that reinforcements were under personal control rather than external factors (Anderson, 1977). Therefore, objective stress alone might not be truly reflective and a valid measure.

In addition, the lack of postpartum maternal stress control in their study might further account for the discrepancies between the research findings. Postpartum maternal anxiety levels which were included as covariate in this study, was not included in their study despite of its potential contribution to toddlers' language development (La Paro, Justice, Skibbe, & Pianta, 2004). It has been shown that depressive mothers are usually less responsive and

positive when interacting with their children (Campbell, Cohn, & Meyers, 1995) and such parenting and interactive style would have adverse impact on infant's emerging language development (Landry, Smith, Swank, Assel, & Vellet, 2001). Since prenatal anxiety is often associated with postpartum anxiety, the negative effect on language functioning observed in Laplant and his colleague's study might also be ascribed to the presence of postpartum anxiety and is not uniquely contributed by prenatal anxiety.

The present study also did not support the research findings that reported significant positive association between prenatal maternal stress and toddlers' development (DiPietro, Novak, Costigan, Atella, & Reusing, 2006; Davis & Sandman, 2011). These inconsistent findings might be attributable to the selection of different child development measures. In both of the previous two studies, children's language functioning was only measured using the general cognitive assessment tool, Bayley Scales of Infant Development (BSID) (1993), without specifically assessing infant language functioning. Although the Bayley Mental Developmental Index (MDI) consists of a sub-score for receptive and expressive language abilities, it is not clear whether it is a reliable and valid measure representing children's language abilities. This is because such particular area could be masked by the global MDI scores (Cohen, 1983). Siegel, Cooper, Fitzhardinge, and Ash (1995) revealed that many children with normal cognitive ability yet significant language delay at two years old could score MDI within the normal range. Although the previous two studies might be able to reflect a positive association between prenatal maternal mental health problems and toddlers' general cognitive development, such association might not hold true for specific language development.

Implications to understanding of etiology of developmental language impairment

SLI or developmental language impairment has often been described as a very complex phenotype. This is even regarded as a description of a phenotype rather than a

diagnostic category (Bishop, 1994, Webster & Shevell, 2004). SLI has a multiple underlying biological causes of which numerous environmental factors are interacting with each other (Bishop, 2006). Language acquisition is achieved through multiple routes, blockage of a single route can be compensated by another (Bishop, 2006). The absence of an association between maternal psychological states and toddlers' language outcomes in the present study supported this claim. Although a significant association was not found between prenatal maternal anxiety and toddlers' language development, the plausible etiological role of prenatal stress in SLI cannot be totally denied. . It may be possible that the presence of other potential environmental factors may have moderated the negative impact of prenatal anxiety on children's language functioning. For example, family socioeconomic status (SES), a strong predictor of early infant vocabulary development (Hoff, 2003), can be one of those. In the present study, most of the participants were of high maternal education levels and SES which maybe due to their higher compliance and willingness to participate in research studies. Mothers with these properties can often create more language facilitative environment and produce maternal speech characterized by rich lexical and syntactic frames (Hoff, 2003). Such language environment is particularly useful in boosting productive vocabulary inventories (Hoff, 2003) which may account for a higher CCDI scores as measured in the current study. The beneficial effect of these environmental factors could have counteracted the detrimental impact of prenatal maternal anxiety. Further, some mothers with heightened stress tend to seek additional ways to improve children's development as a means to satisfy their parenting requirements and hence alleviate their parenting stress (Deater-Deckard & Scarr, 1996). As such, it is speculated that mothers with higher anxiety levels might also be more readily subject to a parenting style called hot housing which means a 'process of inducing infants to acquire knowledge that is typically acquired at a later

developmental level' (Siegel, 1987, p. 212). These mothers were shown to be more likely to be attracted to commercial products and courses such as baby sign classes as a hope to enhance their infants' language development (Howlett, Kirk, & Pine, 2010). These may further provide language-stimulating environment to facilitate infant language growth. In sum, language development is affected by multiple environmental factors and may not be biologically programmed by prenatal stress. The lack of association revealed in the study highlighted other potential mediating variables including maternal characteristics and parenting style which were not controlled in the study and may play a more important role in shaping children's language development.

Limitations

Several limitations have been identified in this study. First, besides postpartum maternal anxiety, there might be other residual confounding variables such as maternal characteristics and parenting style that could more accurately explain the lack of significant association between prenatal maternal anxiety and infant language development. Further, as mentioned, postpartum maternal stress mainly interferes with children's language development by affecting mother-child interaction. The control of postnatal measure using a non-pregnancy specific scale in the present study may fail to exert adequate control for such mediating effect of parenting behavior.

Besides, the children outcome measure was based on a self-rating questionnaire. Although CCDI has been proved to have good reliability and high validity and predictive power for language delay (Fenson et al., 1993), reporting bias and the lack of reliability check should always be of concern. This is particularly true for parental reports as parents tended to have an attributional bias towards their children's development due to their own subjective perceptions and expectations (Seifer, Sameroff, Dickstein, Schiller, & Hayden,

2004). As outcome measures using CDI are mainly based on maternal judgments about their infants and might not be able to attain a high level of consensus, part of the variance might be contributed by the perceiver instead of the actual language output of the toddlers. And in particular, some mothers in the present study were psychologically stressed. They might rate their children more positively to satisfy their basic parental functions. Such phenomenon is particularly common when children start to interact with parents and show high dependence on them for meeting basic daily needs while having limited communication skills. Likewise, in the current study, while children have just started to develop language competence at 2 years old, parents would possibly over-rate their toddlers' language productions as a self-fulfillment of parenting roles.

Another limitation of the study would be the small sample size and lack of heterogeneity of participants. A majority of the participants were with high maternal educational status and SES. This pre-selection of participants may account for the potential covariate of maternal characteristics and lack of representation for the general population.

Future Studies

To investigate the relationship between prenatal maternal stress and children's language functioning in a more comprehensive way, future study using direct observation measures to minimize self-reporting bias that could interfere accuracy of outcome measures, for example using speech samples of the toddlers collected in free play can be a more reliable measure to represent the child's performance. As for maternal measures, observation about the parent interaction style can provide even more information about maternal speech and parenting style which can be a good indicator about postnatal influence. A more extensive research with a larger sample size is also merited to obtain a more representative sample.

Conclusion

Findings from the current research can provide preliminary information in understanding the role of prenatal maternal stress in toddlers' language functioning. The current study was the first of its kind to examine the contribution of prenatal maternal mental problem in the language development of human offspring in a prospective cohort of mothers and children who were carefully followed-up and assessed across pregnancy and after childbirth while controlling for potential postnatal factors. This laid the foundation for future studies in studying such association in a more comprehensive way with more carefully controlled variables.

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Appendix A

Informed consent for participation in the study

婦女懷孕期間的身心健康狀況與幼童語言發展之關係研究

Study of the Impact of prenatal mental health problem on language ability of the offspring

同意書

Informed Consent

1. 本人 * 同意／不同意　參與是項計劃□□□□□□□□□□ _____(□□□□)□□□。有關此計劃的資料以及要參與的測試活動 (包括附件中的內容及程序)，我已清楚明白。本人知道此項計劃所得資料是用作研究及/或教學用途。

   I *consent / do no consent to participate in the above project and agree to provide information about my child _____(name of the child). The particulars of which – including details of tests and treatment procedures – have been explained to me and are appended hereto. The project is for the purpose of research and/or teaching and no fees have to pay for the treatment.

2. 並已接收面值港幣$100元的超市現金券。

   And have received the offer of a supermarket voucher of HK$100.

母親姓名:		研究員姓名:	
Mother's name:	_____	Investigator's name:	_____
母親簽署:		研究員簽署"	
Mother's signature:	_____	Investigator's signature:	_____
日期 Date:		日期 Date:	
	_____		_____

Appendix B

Questionnaires for demographic information of participants

婦女懷孕期間的身心健康狀況與幼童語言發展之關係研究

家長問卷

請家長填寫以下問卷，所有個人資料均會保密。謝謝!

填寫人與幼兒之關係：　　母子 / 母女 / 父子 / 父女 / 其他：_____
填卷日期：　　_____年_____月_____ 日

請填上答案或在適當的空格上填上√號：

1. 幼兒共有多少個兄弟姊妹？（不包括幼兒自己）_____個
（幼兒排行第_____）

2. 幼兒主要由誰人照顧？
□ 父 / 母 □祖父 / 母 □傭人 □其他：_____

3. 幼兒與各家中成員所用的語言或方言（可選超過一項）
父母 □ 廣東話 □普通話 □英語 □其他：_____
外 / 祖父母 □ 廣東話 □普通話 □英語 □其他：_____
兄弟姊妹 □ 廣東話 □普通話 □英語 □其他：_____
傭人 □ 廣東話 □普通話 □英語 □其他：_____

4. 幼兒曾否接受言語治療，物理治療，職業治療或其他治療？
□ 否 □ 是（□言語治療 □ 物理治療
□ 職業治療 □ 其他：_____）

5. 幼兒家庭成員曾否有言語障礙？
□ 否 □ 是（成員是：_____ 其障礙是：_____）

6. 幼兒父親教育程度 □ 小學或以下 □中學 □專上、大學或以上

7. 幼兒母竟教育程度 □ 小學或以下 □中學 □專上、大學或以上

8. 全家總入息： □ 一萬元以下 □一萬至三萬元 □三萬元以上

問卷完，請交回機構負責人。謝謝!