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Do mothers who are anxious during pregnancy have inattentive children?

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Abstract:

Background- Maternal somatic anxiety during pregnancy may affect neural foetal development via corticoid pathways. Using a large epidemiological cohort, this study explores the relationship between maternal somatic anxiety in pregnancy and child scores on the Test of Everyday Attention in Children (TEA-Ch).

Methods- Linear regression was used to analyse the association of maternal somatic anxiety during pregnancy and performance of children on three subtests of the TEA-Ch at age 8.5 years that assess selective attention (Sky Search), sustained attention (Sky Search Dual Test) and attentional control (Opposite Worlds).

Results- Children with complete data on each subtest were included in the analysis, comprising 4,198 children for the Sky Search subtest, 3,845 for the Sky Search Dual Test and 4,202 for the Opposite Worlds subtest. No association was found between exposure to maternal somatic anxiety and child's performance in any of the TEA-Ch subtests either before or after adjusting for confounders. The results did not change when stratifying by gender.

Limitations- Selective attrition, lack of sensitivity of tests and lack of adjustment for the postnatal environment are possible limitations to this study.

Conclusions- We found no evidence of an association between exposure to maternal somatic anxiety in pregnancy and TEA-Ch scores. These results suggest that anxiety during pregnancy does not affect the development of children's attentional skills measured by TEA-Ch.

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Key words: attention, anxiety, pregnancy, ADHD, hyperactivity, ALSPAC.

Highlights

Maternal prenatal anxiety may programme child's behaviour to facilitate survival.

Evidence exists of an association between maternal prenatal anxiety and hyperactivity

Using the TEA-Ch, attentional skills were measured in children at 8.5 years of age.

Somatic anxiety during pregnancy did not affect attentional scores in these children.

Prenatal anxiety does not appear to programme the child's brain towards inattention.

Background

The “developmental origins of health and disease model” (also known as foetal programming) proposes that prenatal environmental conditions such as nutritional deficiencies or maternal stress can elicit a biological programming response in the foetus in order to adapt more readily to postnatal adversity (Barker, 1990). A classic example of this type of prenatal adaptation is the increased insulin resistance found in children of malnourished mothers (Swanson and Wadhwa, 2008). Since both the brain and the placenta have endocrine functions, the idea that programming can extend to the brain of the child while in utero has been proposed. Animal studies have suggested that the intrauterine environment may programme the foetal brain for certain behavioural traits (Schlotz and Phillips, 2009). Early evidence of a possible role for foetal brain programming in humans came from studies of the Dutch famine. Researchers in Holland traced children born to mothers who survived the “Winter of hunger” of 1944 and found increased prevalence of antisocial and schizoid personality disorders (Neugebauer et al., 1999). A possible explanation for this effect is interference from maternal stress hormones with neural migration and dendritic growth in key areas of the foetal brain (Power and Schulkin, 2005). Glucocorticoids are frequently suggested as metabolic targets for the transmission of stress from the mother to the child (Manojlović-Stojanoski et al., 2012). Different brain areas have been implicated in ADHD. Current research characterizes ADHD as a disorder of reduced connectivity of the default network , a set of brain regions in charge of wakeful rest, in other words of maintaining brain conscious activity when not engaged in an specific task (Callard and Margulies, 2014). This circuit encompasses the precuneus/posterior cingulate cortex, the medial prefrontal cortex and the medial, lateral, and inferior parietal cortex (Konrad and Eickhoff, 2010). This system receives information from the amygdala, thalamic and extra-thalamic structures. Decisions in the prefrontal cortex are made by a mechanism of “voting” from various independent nuclei, which appear to subspecialize in specific tasks, such as motivation (ventral medial PFC), spatiotemporal coordination and direction of attention (dorso medial and anterior cingulate) (Faw, 2003). Glucocorticoid receptors, once thought to be limited to the thalamus, are abundant in extrahypothalamic areas, including some regions of the prefrontal cortex, particularly the medial prefrontal cortex. Some studies

have indicated that these neurodevelopmental abnormalities could alter the balance between inhibitory and excitatory circuits in the brain, increasing the severity of ADHD symptomatology in the child (Van den Bergh and Marcoen, 2004). Other pathways which may or may not be related to the Hypothalamic Pituitary Adrenal axis (HPA) and glucocorticoid metabolism have recently been discovered (Glover, 2014). High levels of stress during pregnancy have been associated with an increase in interleukins and other inflammatory markers— whether these could affect the child is unknown. Serotonin is a regulator of neuronal growth, favoring neural specialization and promoting generation of synapses. Exposure to serotonin dysregulation produces behavioural changes in animals. Moreover, a serotoninergic pathway has been discovered in the placenta which may be an interface between maternal HPA axis and serotonin regulation in the child (Glover, 2014). Genetic effects have also been discovered that could moderate the effect of maternal anxiety and child's behavior. Genetic variations in the coding of the enzyme catechol-O-methyltransferase (COMT), have been showed to influence the association between maternal prenatal anxiety, child ADHD symptoms and infant's working memory. COMT is involved in the breakdown of catecholamine neurotransmitters including dopamine, noradrenaline and adrenaline (O'Donnell et al., 2017).

Maternal depression during pregnancy and child rearing has been associated with increased risk of Attention Deficit and Hyperactivity Disorder (ADHD) in children (Foulon et al., 2015; Galera et al., 2011; Sagiv et al., 2013). Few studies have examined the effects of prenatal anxiety. Loomans and colleagues found increased rates of ADHD in boys but not in girls exposed to antenatal anxiety assessed at age 5 (Loomans et al., 2011). O'Connor and colleagues using data from the ALSPAC cohort found an association with hyperactivity in boys at age 4 and boys and girls at age 7 (O'Connor et al., 2002b; O'Connor et al., 2003), while Leis and colleagues did not find an effect at age 11 using the same database (Leis et al., 2014). Van Batenburg-Eddes and colleagues used data from two different cohorts (ALSPAC and Generation R) to examine the association between maternal anxiety in pregnancy and SDQ/CBCL scores in 4 and 3 year olds (Van Batenburg-Eddes et al., 2013). Prenatal maternal anxiety was associated with attentional symptoms. Most studies used symptom scales such as the Strengths and Difficulties Questionnaire (SDQ) and the Child Behaviour Checklist (CBCL) to evaluate outcomes but research where attentional skills have

been measured with validated cognitive tasks is scarce. Van den Bergh and colleagues followed a group of children (aged 15) whose mothers have completed the State Trait Anxiety Inventory (STAI) at 12 and 22 weeks of pregnancy and evaluated them using an encoding task, a stop-go task and a Continuous Performance Test (CPT) (Van den Bergh et al., 2005; Van den Bergh et al., 2006). They found slower reaction times for boys only on the CPT, more errors on the encoding task for both genders and no differences between exposed and non-exposed teenagers in the stop go task. However, the sample of the study was small (57 and 64 respectively), the findings may be due to chance and replication in larger samples is needed.

Aims of study

This study explores the association between exposure to maternal somatic symptoms of anxiety during pregnancy and attentional skills in school age children measured with a cognitive task, the Test of Everyday Attention in Children (TEA-Ch) performed at age 8.5 years. Somatic symptoms of anxiety were chosen because they are easy to detect by screening with validated anxiety scales, are relatively common and frequently improve with psychotropic treatment.

Methods

Participants

The Avon Longitudinal Study of Parents and Children (ALSPAC) is an on-going population based cohort in the former county of Avon (England, United Kingdom). 14,541 pregnant mothers with delivery dates between April 1991 and December 1992 were recruited, resulting in 14,775 live births, of these 13,988 children were alive at 1 year of age. Pregnant mothers and their children were followed for the subsequent 26 years. A complete description of the cohort is available elsewhere (Boyd et al., 2013). More detailed information on the ALSPAC study is available on the website: http://www.bristol.ac.uk/alspac which contains details of all the data available through a fully searchable data dictionary (http://www.bris.ac.uk/alspac/reserachers/data-access/data-dictionary/).

Ethics

Ethical approval for the study was obtained from the ALSPAC Law and Ethics committee and local research ethics committees. Details on ethical approval are available at: http://www.bristol.ac.uk/alspac/researchers/data-access/ethics/.

Measures

Exposure: Maternal somatic anxiety

In the ALSPAC cohort, Information on mental health status during pregnancy was collected at around 18 and 32 weeks of pregnancy using a modified questionnaire based on the Crown Crisp Experiential Index (CCEI) (Crown and Crisp, 1966). This questionnaire had been reduced from the original 48 items to 23, with responses standardized to four distractors ("never", "sometimes", "often", "very often"). The CCEI was developed in the mid 1960s and was divided in a set of six subscales (somatization, depression, free floating anxiety, phobic anxiety, obsessive compulsive symptoms and hysteria). However, the items in these subscales do not correspond to the modern diagnostic definitions of the syndromes they are named after. Moreover, early factor analyses (Alderman et al., 1983) found a substantial overlap between subscales. A group of experts with extensive clinical and epidemiological experience selected five items: "troubled by dizziness or shortness of breath", "felt as though you may faint", "feel sick or have indigestion"," tingling or prickling sensations in body arms or legs" and "extra sweating" from the CCEI. These items were chosen because of their similarity with the ICD-10 and DSM-IV definitions of panic disorder and were judged representative of symptoms of somatic anxiety in mothers (American Psychiatric Association, 2000). Items were grouped and evaluated as a "somatic anxiety factor" using confirmatory factor analysis in two different populations (pregnant women and partners of these women (Bolea-Alamanac and Davies, 2016)). Analyses were performed using Mplus version 7.3 (Muthén, 2010). For the purposes of this study a composite measure of somatic anxiety at 18 and 32 weeks was used since the point of interest was somatic anxiety during pregnancy as exposure regardless of trimester of pregnancy (score range in the sample 10-35). This factor was dichotomized with the problem category being women with the top

20% scores during pregnancy for the main analysis, further analysis were performed with the anxiety factor considered as a continuous measure.

Outcome: Attentional skills

The Test of Everyday Attention for Children (TEA-Ch) was developed from the adult version to examine attentional processes in children aged 6 to 12 years (Heaton et al., 2001). The aim of this test is to assess various subtypes of attention in conditions that recreate real life tasks. This type of assessment stands in contrast to continuous performance tests, in which the primary concern is inhibitory control.

The full battery of tests consists of nine tasks covering selective (2), sustained attention (5) and task switching (2). This three-factor structure has been validated in several samples and various cultural contexts (Chan et al., 2008; Manly et al., 2001). Three subtests were available in the "Focus at 8" Clinic of the ALSPAC sample: Sky Search, Sky Search Dual Task and Opposite Worlds. The first of these examines selective attention, the second sustained attention and the third attentional control (Chan et al., 2008; Manly et al., 2001).

In Sky Search the children are first asked to identify a particular type of spaceship in a sheet of paper that contains the target and some similar drawings. In the Sky Search Dual Task, the child is asked to find spaceships while counting simultaneously tones coming from an audio tape. This test is scored by comparing it to the previous task where no auditory stimulus was used. The Opposite Worlds task is performed in two phases. First, children are asked to name numerals one and two printed along a path drawn on paper. In the second phase, children are asked to say 'one' when there is a 'two' and 'two' when there is a 'one'. TEA-Ch subscores were adjusted for motor speed (motor speed was calculated using a simpler version of the task and then subtracting it from the final score) (Delane et al., 2016; Pardos et al., 2016) and were used as continuous variables.

Confounders

The analysis included potential confounders of the association between maternal anxiety and attentional skills identified in previous literature: child's gender, maternal age (binary variable, cut off >=18 years), social status [(United Kingdom Office of Populations, Censuses

and Surveys classification, binary variable cut off between category 3M “skilled manual occupation” and 3N “skilled non manual occupation”(Rose and Pevalin, 2005)], crowding index (number of people living in the household divided by the number of rooms; binary variable, cut off at 1 person/room), financial difficulties during pregnancy (yes/no), difficulties buying things for the baby (yes/no), alcohol (binary variable, cut off point at >1 glass of alcohol a week), tobacco consumption (binary variable, cut off point at any cigarette smoked), birthweight (binary variable, cut off at <2.5 kg) gestational age (binary variable, cut off point <37 weeks of gestation), maternal education (binary variable, cut off between obtaining O levels and achieving A levels) and paternal support during pregnancy (yes/no) (Leis et al., 2012; O'Connor et al., 2002a; O'Connor et al., 2003; Obel et al., 2011; Odd et al., 2011). Life events were assessed via maternal questionnaires using a survey of 42 questions based on previous scales and designed specifically for ALSPAC (Dorrington et al., 2014) with a cut off at the top 15%. This variable was also weighted to include the impact these events had on the mother and not just their presence or absence.

Maternal somatic anxiety symptoms (continuous variable) when the child was 5 years old (last time point measured), maternal scores in the Edinburgh Postnatal Depression Scale (EPDS) during pregnancy (18 weeks) and when the child was 8 years old (continuous variables) were all included in the sensitivity analysis but dropped from the final model (see methods section).

Statistical analysis

A linear regression model was fitted for each TEA-Ch subscore with maternal somatic anxiety during pregnancy as the independent variable. The first model was a complete case analysis. Covariates were added in three stages. First maternal factors were included: maternal age, education, smoking and alcohol intake during pregnancy, secondly covariates related to child characteristics were added: gender of child, birthweight and gestational age and finally socioeconomic factors were included: difficulties buying items for the baby, life events during pregnancy, social status, crowding index, financial difficulties and partner support during pregnancy. Analyses were performed using STATA software version 13.1 (Statacorp, 2015).

Sensitivity analysis

Several sensitivity analyses were performed using data from the Sky Search task. In a first step a linear regression model was fitted with Sky Search scores as outcome and maternal somatic anxiety when the child was five years old as covariate. In a second step, maternal scores in the Edimburgh Post-natal depression Scale EPDS when the mothers were 18 weeks pregnant and maternal EPDS scores when the child was 8 years of age were included independently as covariates with Sky Search scores as outcomes. Further analyses were performed including child's age as a covariate.

Missing data

Missing data was dealt with using Multiple Imputation with Chained Equations (MICE) (White et al., 2011). Fifty imputations in ten cycles were run which was deemed sufficient for the fraction of missing information found in the sample at 8.5 years. Confounders were imputed using a model that included auxiliary outcome variables but outcomes were not imputed.

Results

Table 1 shows the distribution of all the covariates in the Sky search sample. **Graph 1** shows the distribution of somatic anxiety scores across the maternal sample. A total of 4,198 children had complete data for the Sky Search Task, 3,845 for the Sky Search Dual Task and 4,202 for the Opposite Worlds task. There was no association for the exposure to somatic anxiety in pregnancy and Sky Search subscores (β=0.0010, CI=-0.0129 -0.0149, p=0.887). Adjustment for confounders had little influence on the result (β=0.0016, CI=-0.0157 -0.0125, p=0.821). There was no evidence for an association with the Sky Search Dual Task either. The results for the unadjusted analysis were: β -0.0440, CI=-0.1723-0.0843; p=0.501 and for the adjusted analysis: β=-0.0621, CI=-0.1943 -0.0700, p=0.357. As with the previous outcomes no evidence for an association of somatic anxiety with the Opposite Worlds task subscores was found in the unadjusted (β=0.0045, CI=-0.0427 0.0520, p=0.851) or adjusted

analysis (β=0.0045, CI=-0.0427 0.0520, p=0.851). **Table 2** illustrates all the β coefficients and p values for the analyses described. No association between exposure and outcomes was found either when the sample was stratified by gender . **Supplementary table 2** displays these results. **Supplementary tables 3, 4, 5** show similar results obtained when the maternal anxiety measure considered as a continuous variable.

Sensitivity analyses using maternal anxiety scores five years after delivery did not show an effect of maternal anxiety after birth on attentional scores (β=0.0075,CI= -0.0226-0.0377, p=0.623). Further analyses with the EPDS obtained at 18 weeks of pregnancy and when the child was 8 years old did not show an effect of maternal depressive symptoms after birth or during pregnancy on the child's attentional abilities (β=0.0482, CI=-0.1330-0.2295, p=0.602 and β=0.0082, CI=-0.0025-0.0189, p=0.134, respectively). Further analyses including child's age at the time of taking the test, did not show an effect of children's age in their performance (β=0.15, p=0.1, 95%CI -0.030, 0.034 in unadjusted analyses), possibly because most children were tested at a similar age (average 103 months, standard deviation 3 months).

Results after imputation of missing data

An initial examination of missing data showed that girls were more likely to have missing data in any covariate than boys OR=1.25 (CI=1.16-3.37, p<0.005). Social status and birthweight were the parameters with more missing data in this sample. **Supplementary table 1** compares children with data on the Sky Search subscores with children that did not take the test.**Table 2** shows the β coefficients and p values before and after imputation and adjustment for confounders for each subtest. No evidence was found of an association of prenatal somatic anxiety and TEA-Ch subscores after accounting for missing data.

Discussion

This study found no evidence of an association between maternal somatic anxiety during pregnancy and attentional skills in children measured by three subtasks of the TEA-Ch. The same pattern of results appeared when accounting for missing data using MICE. This stands

in contrast with previous literature suggesting an impact of maternal anxiety during pregnancy on the child's behaviour. Van den Bergh and colleagues used an adaptation of the continuous performance test to assess children exposed to maternal anxiety in utero measured with the State –Trait Anxiety Inventory (STAI) (Van den Bergh et al., 2006) and found slower reaction times in exposed boys but not in girls at age 15. Another study from the same group found increased errors in an encoding exercise of the Amsterdam Neuropsychological Task in both teenage girls and boys exposed to maternal anxiety in pregnancy measured with the same instrument (Van den Bergh et al., 2005). Continuous performance tests explore inhibitory response while the mentioned encoding task focuses on information processing and attentional control. One possible interpretation of our findings is that maternal anxiety impacts specifically on inhibitory control and does not have an effect on the attentional domains measured by the TEA-Ch. Studies in children exposed to pregnancy specific anxiety (mothers that had increased worry circumscribed to pregnancy and delivery) have showed lower inhibitory control in female offspring only and decreased visuospatial memory in both sexes (Buss et al., 2011). Of note is that our model did not find any sex related differences. We could not separate pregnancy related anxiety from other types but we did adjust for a range of negative life events during pregnancy, including obstetric complications.

Previous research on ALSPAC data has showed a relationship between maternal anxiety during pregnancy measured with the anxiety subscale of the CCEI and total difficulties scores on the Strengths and Difficulties Questionnaire (SDQ) (Mennes et al., 2006). The SDQ includes symptoms of hyperactivity and impulsivity as well as inattention, and the total difficulties score is an aggregate of emotional symptoms, conduct problems, hyperactivity/inattention symptoms and peer problems while the TEA-Ch is an assessment exclusively of attentional performance. This may explain the discrepancy of results, as the TEA-Ch is only measuring one domain of ADHD, namely attention, evaluated directly by the child's performance while the SDQ focuses on symptoms as reported by an observer (Goodman, 2001).

The relationship between TEA-Ch scores and ADHD is not straightforward. Manly and colleagues reported significantly worse scores for children with ADHD in sustained attention and switching (Manly et al., 2001), while a study of ADHD patients versus non ADHD

controls found worse outcomes in sustained attention and in one subtask of attentional control (Heaton et al., 2001). The effects of ADHD medication do not seem to span all subtests either. Heaton and colleagues did not find significant differences between treated and untreated children (Heaton et al., 2001) while Paton reported improvements in at least one of each subset of tests (Paton et al., 2014). In general, neuropsychological tests point to a heterogeneous range of deficits in the attentional domain which are not necessarily linked to specific ADHD subtypes (Bolea-Alamanac et al., 2014). Neuropsychological tests are valuable when searching for endophenotypes in ADHD, but cannot replace clinical evaluation when aiming for a clinical diagnosis (Sonuga-Barke et al., 2008). For example, executive function tests can predict ADHD when deficits are found but cannot discard the diagnosis when no abnormalities appear (good positive predictive value and poor negative predictive value)(Nutt et al., 2007). Additional difficulties are problems with test uniformity and standardization across studies and the lack of research on the stability of endpoints over time. Some authors also argue the ecological validity of these tests (Barkley and Fischer, 2011) and propose a comprehensive neuropsychological assessment including executive and non-executive function tests (Gupta et al., 2011).

Limitations

Our results do not support the theory of prenatal neural programming by maternal anxiety producing attentional deficits later on in life. However, this research has a number of limitations. Only three subtests of the TEA-Ch were available for the sample, though these subtasks are purported to evaluate a variety of attentional skills it is possible that on their own they are not sensitive enough to offer an adequate picture of the general attentional ability of a child. Perhaps, these deficits are subtle and cannot be identified before a certain age. The relationship between TEA-Ch scores and ADHD pathology is arguable, while the clinical syndrome is well defined; the cognitive patterns associated with it are not. Current understanding of cognitive deficits in ADHD suggests a mosaic of patterns with some children showing deficits detectable by psychometric testing while others approximate normality (van Rooij et al., 2015). Maternal anxiety was measured with a relatively old and currently disfavoured instrument; to correct for this a confirmatory factor analysis of the scale was necessary. This CFA was tested in two populations: women and men of the

ALSPAC cohort but its validity could not be assessed outside the ALSPAC sample, because the scale had been adapted specifically for this cohort so the factor structure could not be replicated in samples that had used the original instrument. The measure chosen was named “somatic anxiety” because it included symptoms of anxiety that were related to somatic sensations which are easy to detect and report by patients. It can be argued that these symptoms are not sufficiently specific of any type of anxiety disorder. Additionally, it may be difficult to compare our results with other studies that utilized more conventional measures of anxiety.

The ALSPAC cohort suffers attrition with a peak of loss of data from the end of pregnancy up to 3.5 years and another in early adolescence (11-12 years). It is possible that children of mothers with higher levels of anxiety dropped from the study more often than children of healthy mothers particularly if their offspring had problems with attention. Because the attentional measure was taken at 8.5 years this could have attenuated the association between exposure and outcome. Selective attrition towards healthier and richer families has been described for ALSPAC (Howe et al., 2013). However, results after imputation which corrects for missing data did not show an association between exposure and outcome either.

The effect of medication for anxiety in pregnancy could not be controlled for due to lack of specific information about drug prescription. It was however, unusual in the early 90s clinical practice in the UK to administer anxiolytics or antidepressants for the first time during pregnancy.

Protective effects of the postnatal period may have also contributed to attenuation of effect such as maternal treatment, maternal or school support, cognitive stimulation and the influence of other family members including fathers, grandparents and siblings, these effects could not be adjusted for and may have moderated the results.

Conclusions

In summary, the results of this study did not show an impact of maternal somatic anxiety during pregnancy on TEA-Ch performance in children. This does not preclude that maternal somatic anxiety in pregnancy has psychological and behavioural consequences in the child

but does suggest a relative resilience of foetal attentional circuits to external stressors. Further evaluation of exposed children at later stages and studies focusing on children with a clustering of adversity and maternal stress may reveal an effect that is not visible in a relatively healthy population cohort. Future work in this area is required in order to fully elucidate the impact of maternal somatic anxiety in the child's attentional abilities.

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Table 1. Distribution of covariates in the sample of children with complete data in the Sky search subtest and all covariates at 8.5 years (N=4,198).

	N	%
Gender		
Male	2,115	50.4
Female	2,083	49.6
Birthweight		
>2.5 kg	4,077	97.1
<=2.5 kg	121	2.9
gestational age		
>=37 weeks	4,036	96.1
<37 weeks	162	3.9
Maternal age		
>=18	4,171	99.4
<18	27	0.6
Alcohol use during pregnancy(glass/week)		
<=1	4,135	98.5
>1	63	1.5
Smoking during pregnancy		
No	3,726	88.8
Yes	472	11.2
Maternal education		
>=A levels	2,186	52.1
<=O levels	2,012	47.9
Crowding index		
<=1	3,504	83.5
>1	694	16.5
Social status		
>=3m	3,582	85.3
<=3N	616	14.7
Difficulties buying things for the baby		
No	3,402	81.0
Yes	796	19.0
Life events		
Remainder	3,613	86.1
Top 15%	585	13.9

Financial difficulties		
No	3,944	93.9
Yes	254	6.1
Partner was supportive during pregnancy		
Yes	3,871	92.2
No	327	7.8
Partner was affective during pregnancy		
Yes	3,780	90.0
No	418	10.0

Graph 1. Distribution of somatic anxiety scores in the sky search sample (N=4,198)

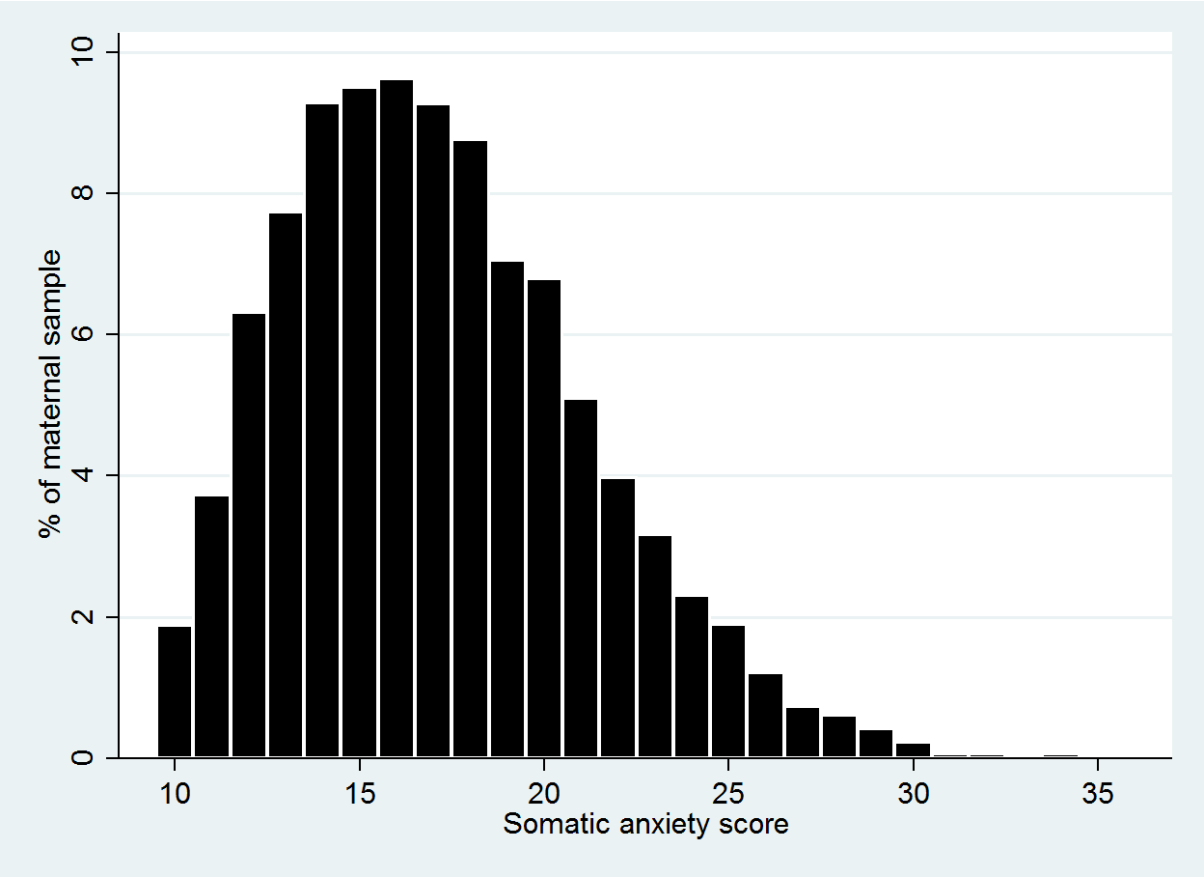

Table 2. β coefficients and 95% confidence intervals for the association between maternal somatic anxiety in pregnancy and offspring subscores on the Sky Search subtest of the TEA-Ch. The maternal somatic anxiety factor was extracted from the CCEI using confirmatory factor analysis. It includes the following items: dizziness, fainting, nausea, tingling and sweating.

VARIABLES	Unadjusted Model	Adjusted 1: maternal factors	Adjusted 2: child factors	Adjusted 3: sociodemographic factors	Fully adjusted imputed sample
Sky search					
β-coef. Somatic anx.	0.0010	0.0003	0.0006	0.0016	-0.0055
95% conf. Interval	-0.0129 0.0149	-0.0135 0.0142	-0.0130 0.0142	-0.0157 0.0125	-0.0175 0.0065
Observations	4,198	4,198	4,198	4,198	7,284
R-squared	0.000	0.007	0.040	0.0406	0.0430
p	0.887	0.963	0.926	0.821	0.371
Sky search DT					
β-coef. Somatic anx.	-0.0440	-0.0453	-0.0427	-0.0621	-0.0472
95% conf. Interval	-0.1723 0.0843	-0.1738 0.0833	-0.1710 0.0855	-0.1943 0.0700	-0.1627 0.0682
Observations	3,845	3,845	3,845	3,845	7,284
R-squared	0.0001	0.0011	0.0070	0.0086	0.0099
p	0.501	0.490	0.514	0.357	0.422
Opp.Worlds					
β-coef. Somatic anx.	0.0045	0.0021	0.0029	-0.0047	-0.0022
95% conf. Interval	-0.0427 0.0520	-0.0452 0.0494	-0.0444 0.0502	-0.0536 0.0441	-0.0364 0.0321
Observations	4,202	4,202	4,202	4,202	7,284
R-squared	0.0000	0.0018	0.0025	0.0047	0.0091
p	0.851	0.932	0.905	0.850	0.901

Adjusted 1: Maternal age, maternal education, smoking and alcohol intake during pregnancy. **Adjusted 2**: Further adjusted for gender of child, birthweight and gestational age. **Adjusted 3**: Further adjusted for difficulties buying items for the baby, life events, social status, crowding index, financial difficulties, partner being supportive and partner being affective during pregnancy.
TEA-Ch=Test of Everyday Attention in Children. CCEI= Crown-Crisp Experiential Index.

Supplementary table 1. Comparison of main covariates in children that took the Sky Search Task and children that did not.

Children that took the Sky Search Task			Children that did not take the Sky Search Task	
	N	%	N	%
Sex				
Male	3,338	24.3	3,766	27.4
Female	3,348	24.3	3,305	24.0
Total	6,686	48.6	7,071	51.4
Birthweight				
>2.5 kg	5,534	54.1	4,323	42.3
<=2.5 kg	189	1.8	180	1.8
Total	5,723	56.0	4,503	44.0
gestational age				
>=37 weeks	6,390	44.9	6,631	46.6
<37 weeks	299	2.1	909	6.4
Total	6,689	47.0	7,540	53.0
Maternal age				
>=18	102	0.7	499	3.5
<18	6,587	46.2	7,085	49.6
Total	6,689	46.9	7,584	53.1
Alcohol use during pregnancy(glass/week)				
<=1	6,410	50.1	6,152	48.0
>1	117	0.9	128	1.0
Total	6,527	51.0	6,280	49.0
Smoking during pregnancy				
No	5,649	43.8	4,739	36.7
Yes	889	6.9	1,634	12.7
Total	6,538	50.6	6,373	49.4
Maternal education				
A levels or more	3,672	30.2	4,195	34.5
O levels or less	2,785	22.9	1,513	12.4
Total	6,457	53.1	5,708	46.9
Crowding index				
<=1	4,893	48.0	2,926	28.7
>1	1,176	11.5	1,195	11.7
Total	6,069	59.6	4,121	40.4
Social status				
>=3m	4,685	47.5	3,209	32.6
<=3N	894	9.1	1,067	10.8

Total	5,579	56.6	4,276	43.4
Difficulties buying things for the baby				
No	4,928	41.6	3,834	32.4
Yes	1,367	11.5	1,709	14.4
Total	6,295	53.2	5,543	46.8
Life events				
Remainder	5,085	46.3	4,039	36.8
Top 15%	902	8.2	948	8.6
Total	5,987	54.6	4,987	45.4
Financial difficulties				
No	5,799	49.0	4,858	41.0
Yes	496	4.2	685	5.8
Total	6,295	53.2	5,543	46.8
Partner was supportive during pregnancy				
Yes	5,717	48.1	4,614	38.9
No	636	5.4	907	7.6
Total	6,353	53.5	5,521	46.5
Partner was affective during pregnancy				
Yes	5,609	47.6	4,624	39.2
No	715	6.1	841	7.1
Total	6,324	53.6	5,465	46.4

Supplementary table 2. Odds ratios and 95% confidence intervals for the association of maternal somatic anxiety and Sky search, Sky search Dual Task (Sky search DT) and Opposite Worlds attentional subscores at age 8.5 years by gender (unadjusted for other covariates).

VARIABLES	Females	Males
Sky search subscore		
Somatic factor	1.01	1.00
P	0.423	0.728
Confidence Interval	(0.99 - 1.02)	(0.97 - 1.02)
N	2,083	2,115
Sky Search DT		
Somatic factor	0.91	1.00
P	0.204	0.981
Confidence Interval	(0.79 - 1.05)	(0.81 - 1.23)
N	1,924	1,921
Opposite Worlds		
Somatic factor	0.99	1.02
P	0.836	0.403
Confidence Interval	(0.91 - 1.08)	(0.98 - 1.06)
N	2,098	2,104

Supplementary Table 3. β –coefficients and 95% confidence intervals for the association between maternal somatic anxiety in pregnancy and offspring subscores on the Sky Search subtest of the TEA-Ch. The maternal somatic anxiety factor was calculated as a continuous measure for this analysis.

VARIABLES	Unadjusted	Confidence Interval
Sky search		
Somatic Anxiety	0.0010	-0.01 - 0.01
Observations	4,198	
p	0.887	

VARIABLES	Adjusted Maternal Child and Sociodem.Factors	Confidence Interval
Sky search		
Somatic anxiety*	-0.0016	-0.02 - 0.01
Observations	4,198	
p	0.821	

Supplementary Table 4. β –coefficients and 95% confidence intervals for the association between maternal somatic anxiety in pregnancy and offspring subscores on the Sky search Dual Test (DT) subtest of the TEA-Ch. The maternal somatic anxiety factor was calculated as a continuous measure for this analysis.

VARIABLES	Unadjusted	Confidence Interval
Sky search DT		
Somatic anxiety	-0.044	-0.17 - 0.08
Observations	3,845	
p	0.501	

VARIABLES	Adjusted Maternal Child and Sociodem.Factors	Confidence Interval
Sky search DT		
Somatic Anxiety	-0.062	-0.19 - 0.07
Observations	3,845	
p	0.357	

Supplementary Table 5. β –coefficients and 95% confidence intervals for the association between maternal somatic anxiety in pregnancy and offspring subscores on the Opposite worlds subtest of the TEA-Ch. The maternal somatic anxiety factor was calculated as a continuous measure for this analysis.

VARIABLES	Unadjusted	Confidence Interval
Opposite worlds		
Somatic anxiety	-0.0036	-0.02 - 0.01
Observations	4,202	
p	0.548	

VARIABLES	Adjusted Maternal Child and Sociodem.Factors	Confidence Interval
Opposite worlds		
Somatic anxiety	-0.000041	-0.01 - 0.01
Observations	4,202	
p	0.995	