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Cognitive processing biases associated with fear of childbirth

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ABSTRACT

Fear of childbirth (FOC) is a phobic-like response concerning the prospect of giving birth. FOC can have negative implications for women during pregnancy and can impact their birthing experience. Cognitive processing biases (e.g., difficulty disengaging from threatening information, interpreting ambiguous information as threatening, and preferentially recalling threatening content) have previously been found to maintain general anxiety and low mood. To date, there has been no research assessing these attention, interpretation, and memory biases and their relationship with FOC in pregnant women. Accordingly, in this cross-sectional study, participants who were at least 12 weeks pregnant ($n = 116$), recruited through a local hospital trust, completed tasks assessing attention (emotional Stroop task), interpretation (scrambled sentences test), and explicit memory (recognition task) biases with materials including FOC-related content. They also completed three separate measures of FOC and measures of low mood, general anxiety, worry, and rumination. We found that a negative interpretation bias (but not attention or explicit memory biases) was associated with higher levels of FOC. These findings indicate that women presenting with higher FOC are more likely to demonstrate negative interpretation biases for ambiguous information relating to childbirth, which may inform research developing interventions to support women presenting with FOC.

1. Introduction

Across cultures, pregnancy and childbirth are seen as major life events and, while joyful for many, can also create high levels of stress (Epifanio et al., 2015; Hutteman et al., 2014), with some women[1] reporting anxiety during this period (Brunton et al., 2019). Fear of Childbirth (FOC) is defined as anxiety about the process of giving birth (Saisto & Halmesmäki, 2003). It involves specific worries centring around fear of the unknown, fear of pain, capacity of the body to give birth, adequacy of support from care providers, potential injury to mother and baby, and losing control (Sheen & Slade, 2018; Slade et al., 2019). Literature distinguishes between primary and secondary FOC, suggesting there are different pathways for the acquisition of the fears (Rondung et al., 2016). Nulliparous women's (those who have not given birth previously) fear (primary FOC) is usually focused on the uncertainties that birth holds, such as fear of pain, the body's ability to give birth successfully, and general fear around the novel experience (Shakarami et al., 2021). By contrast, parous women (those who have previously given birth) may have previous negative experiences of childbirth resulting in secondary FOC (Nilsson et al., 2010; Wigert et al., 2020). The overall pooled prevalence for clinical levels of FOC from 18 countries is 14% (O'Connell et al., 2017). Prevalence rates can vary widely between countries, which is hypothesised to be a reflection of the scales used to measure FOC and the lack of content validity (Nilsson et al., 2018; Saisto & Halmesmäki, 2003).

FOC concerns have the potential to cause women high levels of distress, which can have negative implications for experiences of pregnancy, the subsequent birth experience, and also postnatal mental health (Nilsson & Lundgren, 2009; Nilsson, Lundgren, Karlström, & Hildingsson, 2012). Antenatal distress is linked to higher rates of prolonged labour (Adams et al., 2012; Laursen et al., 2008), premature delivery (Orr et al., 2007), and poorer mental health outcomes in the postpartum period (Sieber et al., 2006). Women with higher levels of FOC are also at higher risk of post-traumatic stress disorder (Slade et al., 2019). Furthermore, half of women presenting with high levels of FOC report comorbid clinical levels of anxiety and depression (Storksen et al., 2012). State and trait anxiety are associated with FOC (Alipour et al., 2011), and higher levels of FOC are highly correlated with traumatic

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[1] The authors wish to acknowledge that not all people giving birth will identify as women and the issues discussed throughout this paper may potentially relate inclusively to all those experiencing pregnancy.

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stress (Söderquist et al., 2004). Therefore, FOC, anxiety and depression may have common underpinnings, such as sharing similar underlying cognitive processes, but this has not yet been explored.

In particular, cognitive processing biases, which underpin anxiety and depression (Everaert, Podina, & Koster, 2017; Hirsch et al., 2016) and transdiagnostic repetitive negative thinking, such as worry and rumination (Hirsch & Mathews, 2012; Krahé et al., 2019), may be linked to FOC. When viewing threatening information, individuals with high levels of anxiety are more likely to attend to the threat stimuli (Fontenot et al., 2015), more likely to interpret ambiguous information as threatening (Krahé et al., 2019) and more likely to remember threatening stimuli (Bomyea et al., 2017). Bottom-up processes of attentional and interpretation biases (also termed cognitive biases or emotional processing biases), together with top-down impaired attentional control have been proposed to maintain pathological worry (Hirsch & Mathews, 2012). Specifically, selective attention towards threatening stimuli that match the individual's thought content (Mathews & MacLeod, 2005) coupled with a negative interpretation bias of neutral information maintains worry in individuals with high levels of anxiety (Hirsch & Mathews, 2012). In the current paper, we investigated the association between cognitive biases and FOC.

Attentional bias is defined as a tendency to pay attention to stimuli that are congruent with an emotional state, and to have difficulties disengaging from these stimuli (Cisler & Koster, 2010; Koster et al., 2006). In relation to FOC, women may be particularly prone to attending to negative childbirth-related words and have trouble disengaging from these words. This bias can be assessed using an emotional Stroop task (Stroop, 1935). The Stroop task measures reaction times to naming the colour in which neutral and threat-related words are written, with slower reaction times to threat stimuli indicating difficulties disengaging attention from the threat-related meaning of the word.

Interpretation bias is associated with increased worry and rumination (Krahé et al., 2019), and has been found to be present across emotional disorders (Hirsch et al., 2016). In relation to FOC, women may interpret relatively ambiguous situations in a negative manner. For example, they may interpret ambiguous bodily sensations as confirmation that birth will be unmanageable, and these kinds of interpretations have the potential to lead to further negative conclusions which maintain FOC. Interpretation bias has been examined in relation to a range of mental health difficulties, including GAD and depression (Everaert et al., 2017; Krahé et al., 2019), eating disorders (Rowlands et al., 2020), and post-traumatic stress disorder (Bomyea et al., 2017), but not yet FOC. In the present study, we used a scrambled sentences test, in which participants create valenced (either positive or negative) sentences from sets of unordered words, to assess interpretation bias. Using such a task, Krahé et al. (2022) examined different types of repetitive negative thinking and found that trait worry was associated with worry-related but not rumination-related interpretation bias material, while rumination was associated with rumination-related but not worry-related interpretation bias. Thus, such tasks can allow us to examine the specificity of cognitive biases to content, even for closely related constructs. For interpretation bias, further specificity effects include negative interpretation bias pertaining to specific fears (Mobach et al., 2019) and to social situations in the context of social anxiety (Yu et al., 2019). Thus, it is important to take context and content into account when assessing cognitive biases, and we did so by including both general anxiety and FOC content in our tasks.

Lastly, memory bias is defined as the more accurate retrieval of information that is consistent with an individual's present emotional state (Moritz et al., 2005). While not part of the model of pathological worry, and less consistently implicated in anxiety than attention and interpretation biases, there is evidence that memory is biased towards threat-related information retrieval in PTSD (Bomyea et al., 2017; Herrera et al., 2017). Individuals with higher levels of social anxiety are more likely to interpret a social situation negatively, and more likely to have a bias for more negative memories of the event (Hertel et al., 2008). Thus, we also assessed memory bias in relation to FOC, using a recognition task with both novel and encoded (part of the Stroop task) stimuli, and asking participants to determine whether or not they had seen the word previously.

In perinatal contexts (including up to one year postpartum), cognitive biases have been reported in women who experience postnatal depression (Webb and Ayers, 2015). Women with depression are more likely to have an attentional bias for infant faces that are expressing sad emotions, and are more likely to interpret ambiguous/neutral infant expressions as negative (Webb and Ayers, 2015). Women with higher levels of FOC report having more thoughts related to childbirth compared to women who report low levels or no fear (Hildingsson et al., 2010). Cognitive bias modification, in which participants are coached to make more positive interpretations, has been found to reduce negative thought intrusions (though FOC was not measured) for pregnant women (Hirsch et al., 2021). However, as noted above, relationships between cognitive biases and levels of FOC, and whether these associations might be more pronounced for FOC-specific materials, have not yet been explored.

1.1. Current study

We investigated the relationship between three cognitive biases, attention, interpretation, and memory, and FOC in pregnant women from the general population presenting with varying degrees of FOC. To ensure the stimuli used in the task were relevant to the symptoms under consideration (Hirsch et al., 2016), we used existing stimuli relating to anxiety. Additionally, we created new FOC stimuli relating specifically to fears around childbirth together with women who were pregnant or had recently given birth. Furthermore, given links between FOC and distress, we examined the relationship between FOC, general anxiety, and mood, and additionally repetitive negative thinking associated with anxiety and low mood, namely worry and rumination.

We expected that FOC would be positively correlated with worry, rumination, general anxiety, and low mood (Hypothesis 1). We then tested the hypothesis that a more negative attentional bias, interpretation bias, and memory bias (in general, that is, across anxiety and FOC stimuli) would be associated with higher levels of FOC (Hypothesis 2). Lastly, as we included both general anxiety- and FOC-related materials in two of the tasks, we predicted that there would be a stronger association between FOC and negative attention and interpretation biases for content-specific material (i.e., relating to labour and birth) than for general anxiety/worry-related material.

2. Method

2.1. Design

The study used a cross-sectional design and was conducted online. Each participant completed tasks assessing attentional bias using a Stroop task, interpretation bias using a scrambled sentences test, and memory bias using a word recognition task. Participants also completed three measures of fear of childbirth (as there is currently no consensus on measurement scales; Nilsson et al., 2018; Saisto & Halmesmäki, 2003), and measures of general anxiety, mood, worry, and rumination. We examined associations between FOC, anxiety, worry, mood, and rumination, and between cognitive bias tasks assessing attention, interpretation, and explicit memory biases, and FOC.

2.2. Participants

Participants were at least 12 weeks pregnant. Exclusion criteria were currently receiving care from a psychiatrist for a severe mental illness and being designated by their maternity service to have a high-risk pregnancy. No specific diagnoses were listed as exclusion criteria. Participants that were colour blind were excluded as they would not have

been able to complete the Stroop task.

A power calculation was carried out for a multiple regression analysis and an increase R^2 of 0.10 (small effect size) for including the three predictor variables (representative of each cognitive process) and allowing for two control variables of gestation and parity (the number of times a woman has given birth). The alpha was set to 0.017 (Bonferroni adjusted to account for the three FOC measures), which when setting power to .80 required a sample of 108 cases. We slightly exceeded this sample size with our final sample of 116 participants.

Participants were predominantly white university graduates (see Table 1; some people missed some of the demographic questions, resulting in varying *n* for these items), and the mean gestation when completing the study was 21.53 weeks ($SD = 5.89$; due to a technical error, only $n = 92$ participants provided data on gestation). All participants were female with no participant identifying as non-binary.

2.3. Procedure

Participants were invited to take part in "The Expecting Study: EXPloring pattErns of Common ThinkING styles in pregnancy". Participants were recruited from the Liverpool Women's Hospital via invite sheets that were placed in the envelope with their 20-week scan appointment letter. An advertisement was also placed on the hospital website, and posters were placed in waiting rooms at the hospital with a link to the study (hosted on Qualtrics). No mention of FOC was made on the advertisement. Eligible participants took part online at a time and location of their choosing, and participation typically lasted 40 minutes. The study could only be accessed on a laptop due to the Stroop task requiring a computer keyboard. Participants provided informed consent and completed the scrambled sentences test (interpretation bias), three FOC measures, Stroop task (attention bias), demographic questions, the self-report questionnaires, and the recognition task (memory bias) in this order. Participants could request a £5 voucher as compensation for their time. Ethical approval was granted by the National Research Ethics Committee Yorkshire and The Humber – South Yorkshire Research Ethics Committee (IRAS 291313). Data was collected from November 2021 to February 2022.

2.4. Self-report questionnaire measures

2.4.1. Fear of childbirth

Three FOC scales were used in this study due to varying strengths and weaknesses that are highlighted below. Firstly, we used the Fear of Birth Scale (FOBS). The FOBS (Ternström et al., 2016) is a simple two-item measure assessing levels of fear and worry in relation to the individual's upcoming birth using a 100 mm visual analogue scale. On this scale, participants indicate to what extent they have felt (1) calm/-worried and (2) no fear/fear in relation to their birth (Haines et al., 2011). Due to the scale only having two items, it can be used readily in clinical services. However, it does not provide a high level of information regarding FOC. The cut-off score for the FOBS used in the literature is 50 mm on the visual analogue scale (Haines et al., 2011). The second scale used was the Wijma Delivery Expectancy Questionnaire (WDEQ). This 33-item scale assesses expectancies of childbirth on a response scale ranging from 1 to 6, with higher scores indicating higher levels of FOC (Wijma et al., 1998). This scale is the most widely-used measure for assessing FOC. However, it has been translated from Swedish, and studies using it with an English-speaking population have found major issues in item interpretation (Johnson & Slade, 2002; Roosevelt & Low, 2016; Slade et al., 2019; Toohill et al., 2014). For example, women in the United Kingdom have been uncertain of the meaning of some of the terms used within the scale. They felt the items did not make sense in the context of childbirth and were uncomfortable giving a response (Slade et al., 2019). Formal validation of the WDEQ using a UK population is yet to be completed (Slade, Balling, Houghton, & Sheen, 2022; Slade, Molyneux, & Watt, 2021), however, some studies report that studies should employ a cut-off score of > 85 (Nilsson et al., 2018). The third scale used was the Fear of Childbirth Questionnaire (FCQ). This is a 20-item measure that assesses both emotional and physical fears rated on a scale of strongly disagree, slightly disagree, slightly agree or strongly agree (Slade, Balling, Houghton, & Sheen, 2022; Slade, Molyneux, & Watt, 2021). The items in this scale were created with women who reported high levels of FOC in the UK and systematically address all areas identified as fear- provoking, ensuring that this scale has high content validity. Example items are: "*I worry my labour or birth will not go to plan*" and "*I am worried that my baby will be harmed during labour and birth*". This is a relatively new scale and therefore, other forms of validity and reliability are yet to be verified. However, we felt that including this new scale would be useful. This scale does not yet have a clinical cut-off score as validation is currently ongoing, but higher scores on this measure indicate higher levels of FOC. Cronbach's alphas in the present study were all satisfactory at .83 for the FOBS, .93 for the WDEQ, and .79 for the FCQ.

2.4.2. Worry and rumination

Worry was measured using the Penn State Worry questionnaire (PSWQ). The PSWQ (Meyer et al., 1990) assesses trait worry using 16-items (rated on a scale from 1 to 5), with higher overall scores indicative of higher trait worry. This scale has high internal consistency and validity when used with university and clinical samples (Brown et al., 1992). Rumination was measured using the Ruminative Response Scale (RRS), which has 22 items (rated on a scale from 1 to 4), with

Table 1
Demographic Characteristics.

Ethnicity	*n*	%	Education	*n*	%	Work status	*n*	%	Marital status	*n*	%	Parity	*n*	%
White	98	92.5	No formal education	2	1.9	Employed full time	48	45.3	Single	3	2.8	Nulliparous	74	70.5
Black / African / Caribbean / Black British	4	3.8	GCSE	11	10.4	Employed part time	13	12.3	In a relationship, but not cohabiting	4	3.8	Multiparous	31	29.5
Asian / Asian British	4	3.8	A-levels	5	4.7	Self-employed / Freelance	4	3.8	Cohabiting	16	15.1			
			Vocational training	10	9.4	Unemployed – looking for work	3	2.8	Married	83	78.3			
			Bachelor's degree	56	52.8	Home maker	36	34						
			Master's degree	19	17.9	Student	1	0.9						
			Doctoral degree	3	2.8	Other	1	0.9						

Note: No participant identified as non-binary in this sample. No participant identified as being Gypsy, Irish Traveller or Arab. No participant identified as being in a civil partnership, widowed, or divorced.

higher scores indicating higher levels of rumination (Nolen-Hoeksema & Morrow, 1991). This is a widely used measure with satisfactory internal consistency and good scale reliability and validity when used with people with major depressive disorder (Parola et al., 2017). Cronbach's alphas in the present study were .80 for the PSWQ and .91 for the RRS.

2.4.3. Anxiety and depression symptoms

Levels of general anxiety were measured using the Generalised Anxiety Disorder 7-item scale (GAD-7; Spitzer et al., 2006). Seven items assess the frequency of symptom occurrence in the past two weeks on a response scale from 0 to 3, with higher scores indicating greater anxiety. It has high reported internal consistency and excellent convergent validity (Johnson et al., 2019). The Patient Health Questionnaire (PHQ-9) was used to assess low mood. The PHQ-9 (Kroenke & Spitzer, 2002) is a nine-item measure that assesses the frequency of depressive symptoms over the past two weeks (scale ranging from 0 to 3), with higher scores indicating higher levels of depression. Cronbach's alphas in the present study were .80 for the GAD-7 and .78 for the PHQ-9.

2.5. Cognitive bias tasks

The three emotional processing biases were assessed using three different tasks. An emotional Stroop task assessed attentional bias, the scrambled sentence test assessed interpretation bias, and a word recognition task assessed memory bias. The general anxiety-related stimuli were taken from previous research that had created these specifically for a population presenting with generalised anxiety disorder (Krahé et al., 2019; Krahé et al., 2022). All cognitive tasks were piloted with a group of pregnant women/new mothers ($n = 6$) prior to use in this study.

2.5.1. Creation of FOC-related stimuli

All FOC-related items used in the three bias tasks were co-created with six women who were either currently pregnant or had recently given birth (these women were a separate group to those who piloted the final tasks). The stimuli were developed and tested through a rigorous process to ensure that they were applicable and salient for our purpose and acceptable to the study population. For the Stroop task, words generated by the group were matched to the most common fears reported by women in recent literature (Slade et al., 2019). For the scrambled sentences test, 20 sentences were initially co-created, and ten sentences, which best represented the FOC domains identified by Slade et al. (2019), were retained for use in the study. Example items are presented below, and the full item set can be found in Supplementary Table 1.

2.5.2. Attention bias measure

Many research studies have used a Stroop task to assess attentional bias in individuals presenting with anxiety (Bar-Haim et al., 2007; Fontenot et al., 2015; Mogg & Bradley, 1998). This task was created by Stroop (Stroop, 1935) and is considered to be a valid measure of attentional bias (Cisler & Koster, 2010). Participants completed a computerised emotional Stroop task consisting of 90 experimental trials: 30 FOC-related words (created for this study and including words such as stillbirth, forceps, excruciating, induction, and tearing), 30 general anxiety words (e.g., weak, nervous, failure, foolish, and worried), and 30 neutral words (e.g., scrapbook, parking, eyebrow, chair) were used. The full item set is presented in Supplementary Table 2. Neutral words were included to control for general speed of responding. Neutral words were chosen to match the FOC- and anxiety-related words for frequency and length in the English language. Guttman's λ (a measure of split-half reliability; see Krahé et al., 2022, and Parsons, Kruijt, & Fox, 2019, for a detailed discussion) was .97 (0.5 quantile = .96) for reaction times for FOC-related words, .93 (0.5 quantile = .90) for general anxiety words, and .60 (0.5 quantile = .57) for neutral words, indicating good to excellent split-half reliability.

Participants viewed words in the colours blue, red, orange, and green in random order and were asked to select the colour of each word by pressing the corresponding key on their keyboard as quickly as possible (press the R key for red, press the B key for blue etc). They were asked to ignore the meaning of the word and focus only on the colour in which it was presented. A fixation cross was presented after each word trial. Following the practice trials, participants were shown each stimulus once, resulting in a total of 90 trials. Reaction time was recorded for each trial.

In line with established practice, incorrect answers were excluded from the data (overall error rate was 3.14% for FOC words, 3.26% for anxiety words, and 3.26% for neutral words). Additionally, any trials with reaction times of more than two standard deviations from the participant-specific grand mean were excluded as it was hypothesised that these were indicative of a lack of attention to the task (Kambouropoulos & Knowles, 2005). A standardised residual score (mean reaction time for combined anxiety and FOC-related words controlling for mean reaction time for neutral words) was calculated and included in the analyses. To test specificity, we additionally examined FOC- and anxiety-related stimuli separately (see *Statistical analyses*). Higher scores meant slower reaction times, that is, a greater attentional bias in the direction of the FOC- and anxiety-related words.

2.5.3. Interpretation bias measure

The scrambled sentence test (SST; Wenzlaff & Bates, 1998, 2000) was chosen as a reliable measure of interpretation bias implemented by many studies researching anxiety symptoms and presentations (Krahé et al., 2019; Krahé et al., 2022). The SST included 20 sentences, 10 of which were FOC-related (created for this study) and 10 of which were worry- and anxiety-related (from Krahé et al., 2022). Guttman's λ was .86 (0.5 quantile = .82) for FOC-related stimuli, and .92 (0.5 quantile = .83) for worry/anxiety items, indicating very good split-half reliability.

For each sentence, participants were given six words and asked to make the first grammatically correct sentence that came to mind using five of the six words. An example item for the FOC-related sentences was, "*won't as birth will planned go*" which could be unscrambled to make the sentence "*birth will go as planned*" (positive interpretation) or "*birth won't go as planned*" (negative interpretation). An example of the worry/anxiety-related sentences was "*badly out everything turn fine will*", which could be unscrambled to make the sentence "*everything will turn out fine*" (positive interpretation) or "*everything will turn out badly*" (negative interpretation). Participants were asked to keep in mind a string of six digits as a cognitive load task while they were unscrambling the sentences (Wenzlaff & Bates, 1998, 2000) and were asked to recall the six digits at the end of the task. To further reduce processing capacity, participants had five minutes to complete the task, after which the survey moved on to the next page of the study. An overall individual SST index was calculated by dividing each participant's number of grammatically correct negative sentences by the total number of grammatically correct sentences generated. This produced an index ranging from 0 to 1, with higher scores indicating a more negative interpretation bias. Additionally, we computed separate indices for the FOC- and worry/anxiety-related items. The attention and memory bias tasks both have neutral stimuli that act as a baseline for responding/recall. However, there is no neutral baseline for the interpretation bias task, which by design includes only negatively or positively unscrambled sentences.

2.5.4. Memory bias measure

Explicit memory was measured using a word recognition task, which has been commonly used in the literature with individuals presenting with anxiety (Bomyea et al., 2017; Herrera et al., 2017; Pauli et al., 2005). Participants were shown 44 words in random order and asked a dichotomous yes/no question as to whether they had seen this word previously in the Stroop task. Twenty-two FOC words and 22 neutral words were used (see Supplementary Table 3). GAD stimuli were not included to reduce participant burden. In both the FOC and neutral word

lists, 11 had been shown in the Stroop task and 11 were novel. Guttman's λ was .79 (0.5 quantile = .74) for seen-before FOC words, .78 (0.5 quantile = .74) for novel FOC words, .82 (0.5 quantile = .77) for seen neutral words, and .82 (0.5 quantile = .78) for novel neutral words, indicating good split-half reliability for the different lists.

Correct answers were recorded as 'hits', and response bias (where a participant incorrectly said they had seen a novel stimulus, which had not been presented) were recorded as 'false alarms'. Then, d prime (*d'*) scores were created for the list of FOC-related words and the list of neutral words. D prime is a measure of participants' ability to correctly discriminate between a signal (a previously shown stimulus) and a noise (a novel stimulus; Stanislaw & Todorov, 1999). A participant's *d'* value can range from 0 to infinity, and larger *d'* scores indicate a superior ability to discriminate between signals and noise, or of a stronger memory bias for signals (Stanislaw & Todorov, 1999). A standardised residual score was calculated (FOC *d'* score controlling for neutral *d'* score) for the analyses, with a higher score denoting a greater memory bias for FOC-related words (over and above memory for neutral words).

2.6. Statistical analyses

All analyses were completed using SPSS (Corp, 2020) and Stata 16 (StataCorp, 2019). Preliminary analyses were preformed to ensure that there were no violations of the assumptions of normality, linearity, and homoscedasticity. Outcomes did not violate the assumption of normality.

To test the first hypothesis, correlational analyses assessed the relationship of FOC with worry, rumination, general anxiety, and low mood. To address the second hypothesis, namely that FOC would be associated with a more negative attentional, interpretation, and memory bias, we carried out multiple regression analyses to assess whether the three cognitive biases measured (attention, interpretation, and memory) were associated with FOC. We controlled for parity, as parity was related to one of the FOC outcomes (see *Results*). Gestation was not significantly associated with any of the outcomes, and so we did not include it as a covariate. As predictors of interest, we entered the standardised residual score for the emotional Stroop test as the measure of attention bias (higher scores denoting greater negative bias), the SST index[2] (higher scores denoting greater negative interpretation bias), and the standardised residual for the memory task (higher score denoting greater memory bias for FOC-related words). We ran this analysis separately for each FOC measure (see power calculation). Lastly, to examine Hypothesis 3, that is, to assess whether any associations between FOC and cognitive biases would be more pronounced for FOC-related than for general anxiety-/worry-related stimuli, we focused on the Stroop and SST measures, as the recognition test did not include general anxiety stimuli. For the Stroop, we specified linear mixed models with stimulus type (general anxiety- vs. FOC-related words) and FOC measure and their interaction as predictors and reaction time as the outcome, and controlled for neutral stimuli (i.e., general speed of responding). We ran this analysis separately for each of the three FOC measures. For the SST, we specified linear mixed models with stimulus type (general anxiety- vs. FOC-related) and FOC measure and their interaction as predictors and interpretation bias index as the outcome, and again ran the analysis separately for each FOC measure. The critical significance level for each analysis was set to .017 to account for multiple testing.

[2] No standardised residual was computed here as the SST does not include neutral stimuli.

3. Results

3.1. Descriptive statistics and preliminary checks

3.1.1. Clinical cut-off scores

Nearly half (49.5%) of participants scored above the clinical cut-off score for FOC as measured by the two-item FOBS, and 24.3% of participants scored above the clinical cut-off score for FOC as measured by the WDEQ. Furthermore, 35.7% of participants scored above the clinical cut-off score for general anxiety as measured by the GAD-7, and 49.5% of participants scored above the clinical cut-off score for low mood as measured by the PHQ-9 (see Table 1 for demographic characteristics). For our statistical analyses, we used the continuous scores.

3.1.2. Parity

Independent samples *t*-tests showed that while there were no effects of parity on FOBS scores ($t(103) = -.29$, $p = .772$) or FCQ scores, ($t(103) = -1.84$, $p = .069$), WDEQ scores did differ by parity ($t(103) = -2.35$, $p = .020$; nulliparous $M = 72.39$, $SD = 22.42$ vs. multiparous $M = 60.45$, $SD = 4.77$). Therefore, we controlled for parity in our multiple regression analyses.

3.2. Bivariate correlations

Bivariate correlations are presented in Table 2. The three measures of FOC (FOBS, WDEQ, and FCQ) were strongly and positively correlated with each other. Interpretation bias was also significantly correlated with the other two biases. Specifically, interpretation bias was significantly positively correlated with attentional bias, but significantly negatively correlated with memory bias, while attentional and memory biases were not significantly correlated with each other. Importantly for our hypotheses, higher levels of FOC were significantly correlated with greater worry, rumination, anxiety, and low mood, supporting Hypothesis 1. Gestation was not correlated with any of our outcome measures and was thus not included in the analyses.[3]

3.3. Associations of attention, interpretation, and memory biases with fear of childbirth

Controlling for parity, interpretation bias was a significant predictor of levels of FOC on all three scales used to measure FOC (see Table 3). Specifically, a more negative interpretation bias was associated with higher levels of FOC (see Fig. 1). Neither attention nor memory bias were significant predictors of FOC on any of the three measures used, though interestingly, there were significant bivariate correlations between memory bias and WDEQ, anxiety, depression, and rumination measures (see Table 2). The analysis was re-run to control for general anxiety as measured by the GAD-7, which did not change any of the results: Associations between interpretation bias and FOC remained significant when controlling for general anxiety. Therefore, our hypothesis was consistently supported for interpretation bias, but not for attention or memory bias.

3.4. Testing the specificity of cognitive biases stimuli in relation to FOC

To test Hypothesis 3 that there would be a stronger association between FOC and negative attention and interpretation biases for content-specific material (i.e., relating to labour and birth) when compared to general anxiety/worry-related material, linear mixed models were carried out for the two tasks which contained both stimulus types (i.e., the Stroop and SST). For the Stroop task, neither the effect of FOC nor stimulus type or the interaction between the two were significant for any of the three FOC measures (see Supplementary Table 4), which is

[3] Including gestation in our models did not affect the results.

Table 2
Descriptive Statistics and Correlations.

Variable	*n*	*M*	*SD*	FOBS	WDEQ	FCQ	PHQ-9	GAD-7	PSWQ	RRS	SST	Stroop	RT	Gestation
FOBS	111	47.70	18.50	–										
WDEQ	111	68.48	24.44	0.68 * *	–									
FCQ	111	27.76	7.45	0.60 * *	0.69 * *	–								
PHQ-9	105	9.23	5.28	0.38 * *	0.52 * *	0.47 * *	–							
GAD-7	105	8.00	4.87	0.45 * *	0.41 * *	0.44 * *	0.79 * *	–						
PSWQ	105	46.74	9.66	0.21 *	0.27 * *	0.30 * *	0.43 * *	0.50 * *	–					
RRS	105	45.55	12.21	0.38 * *	0.50 * *	0.42 * *	0.75 * *	0.76 * *	0.51 * *	–				
SST	116	0.28	0.20	0.48 * *	0.55 * *	0.56 * *	0.68 * *	0.61 * *	0.38 * *	0.60 * *	–			
Stroop	103	0.00	1.00	0.01	0.07	0.03	0.14	0.09	0.05	0.14	0.20 *	–		
RT	111	0.00	1.00	0.01	-0.25 * *	-0.13	-0.29 * *	-0.23 *	0.03	-0.28 * *	-0.19 *	-0.13	–	
Gestation	92	21.53	5.89	-0.02	0.09	0.01	-0.09	-0.07	-0.09	0.03	-0.13	-0.06	-0.05	–

Note: * $p < .05$. * * $p < .01$. Scales: FOBS – Fear of Birth Scale, WDEQ - Wijma Delivery Expectancy/Experience Questionnaire, FCQ – Fear of Childbirth Questionnaire, PHQ-9 – Patient Health Questionnaire, GAD-7 – Generalised Anxiety Disorder, PSWQ – Penn State Worry Questionnaire, RRS– Ruminative Response Scale, SST – Scrambled Sentences Test negativity index to assess interpretation bias, Stroop – Standardised residual of threat reaction times (accounting for neutral reaction times) on the emotional Stroop task to assess attentional bias, RT – standardised residual of threat *d'* (accounting for neutral *d'*) on the recognition test to assess memory bias

Table 3
Regression Results for Cognitive Bias Tasks and FOC Measures.

					95% confidence interval		
Outcome variable	Predictor	*b*	Standard error	*p*	lower	upper	*partial* η^2
FOBS	Parity	-0.20	3.41	0.953	-6.96	6.56	0.000
	Attention	-1.51	1.58	0.341	-4.64	1.62	0.009
	Interpretation	48.78	7.82	< 0.001	33.27	64.29	0.287
	Memory	2.28	1.62	0.164	-0.94	5.50	0.020
WDEQ	Parity	8.71	4.35	0.048	0.07	17.35	0.040
	Attention	-1.37	2.02	0.500	-5.37	2.64	0.005
	Interpretation	64.23	9.98	< 0.001	44.42	84.05	0.299
	Memory	-3.20	2.07	0.126	-7.32	0.91	0.024
FCQ	Parity	2.03	1.36	0.138	-0.67	4.74	0.022
	Attention	-0.59	0.63	0.354	-1.84	0.66	0.009
	Interpretation	20.36	3.12	< 0.001	14.16	26.55	0.305
	Memory	-0.14	0.65	0.824	-1.43	1.14	0.001

Note: Scales: FOBS – Fear of Birth Scale, WDEQ - Wijma Delivery Expectancy/Experience Questionnaire, FCQ – Fear of Childbirth Questionnaire. Bias tasks: Attention (Stroop task), Interpretation (scrambled sentences test), Memory (recognition task)

perhaps unsurprising as FOC was not significantly associated with overall attentional bias (see Section 3.3). Regarding the SST, stimulus types were significantly correlated ($r = .78$, $p < .001$). The association of FOC with the SST index was significant for all three FOC measures (as above), but the effect of stimulus type and the interaction of FOC and stimulus type were non-significant for all three FOC measures. Thus, Hypothesis 3 was not supported.

4. Discussion

This cross-sectional study examined the relationships between three cognitive biases (attention, interpretation, and memory) and three measures of fear of childbirth in a sample of women from the general population who were at least 12 weeks pregnant. This is the first study to assess attention, interpretation, and memory bias and their potential associations with FOC in a community sample of pregnant women.

In support of our first hypothesis, we found that higher levels of FOC (on all three measures) were related to higher levels of worry, rumination, general anxiety, and depression, supporting the theoretical links between these constructs.

In partial support of our second hypothesis, a more negative interpretation bias was associated with higher scores on all three measures of FOC. This relationship was still present when we controlled for parity and general levels of anxiety. We did not find a relationship between scores on the attention bias task and FOC, nor did we find evidence for a significant association between memory bias and FOC. Lastly, we did not find any evidence for content specificity.

Considering attention bias, previous studies found that attention bias for stimuli that matched the content of the worries was associated with increased levels of anxiety (Hirsch et al., 2011; Mathews & MacLeod, 2005). We did not find this in relation to FOC. However, due to the task being completed in participants' homes and outside of the lab, there was perhaps an accuracy-speed trade-off (Wickelgren, 1977). Overall mean reaction times for the three groups of words are greater than when emotional Stroop tasks are used in a lab setting (Edvinsson et al., 2017; Staller, Zaiser, Körner, & Cole, 2017), and there were very few errors (maximum three) across the 90-word trials in our study. Additionally, our study did not recruit a specific group of individuals with clinically high levels of FOC, and the average scores on the three measures used to assess FOC did not meet the clinical cut-off score for caseness, although rates of FOC were much higher in this sample than would be expected in an unselected pregnancy group. Interestingly, a large meta-analysis found that across disorders, attentional biases were only found in those with clinical levels of anxiety, and the effect was not observed in non-anxious individuals (Bar-Haim et al., 2007).

The current finding for interpretation bias is in line with studies that have reported an association between general anxiety and interpretation bias in non-pregnant populations (Krahé et al., 2019) and in the perinatal period (Hirsch et al., 2020). Although Hirsch et al. (2020) assessed negative interpretation bias in relation to pregnancy-related anxiety and not FOC, they also found that women who scored higher on a measure of general and pregnancy-related anxiety were more likely to present with a negative interpretation bias. Additionally, a study that used interpretation-modification training found that they were able to induce a positive interpretation bias in a sample of pregnant women experiencing high levels of worry (Hirsch et al., 2021). Therefore, our findings

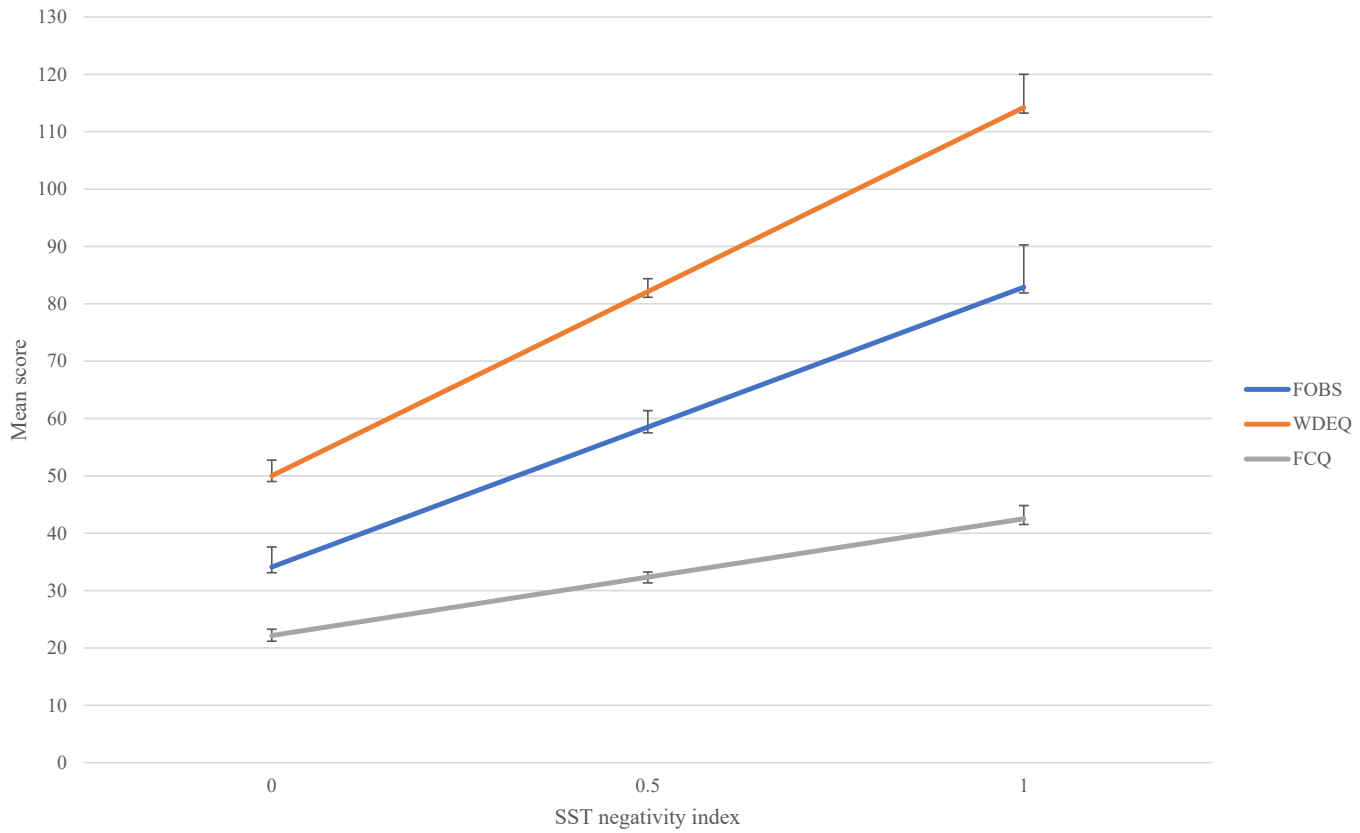

Fig. 1. Significant Associations Between Negative Interpretation Bias (SST Negativity Index) and Higher Levels of Fear of Childbirth (Assessed Using Three Separate Measures, FOBS, WDEQ, and FCQ).
Note. SST – Scrambled Sentences Test; FOBS – Fear of Birth Scale; WDEQ – Wijma Delivery Expectancy/Experience Questionnaire; FCQ – Fear of Childbirth Questionnaire. Error bars denote +/- 1 standard error of the mean

extend this literature into FOC. Our findings indicate that women with higher levels of FOC are likely to negatively interpret ambiguous stimuli irrespective of their parity, gestation time point, and general levels of anxiety. Given the associations were not specific to FOC materials, they could extend to their daily lives; when individuals are faced with ambiguity, they may interpret this negatively. This could then lead to an increase in negative thoughts.

In our study, memory bias was not associated with FOC. When looking at the evidence for explicit memory bias in anxiety disorders and not in a pregnant population, the results are inconsistent. A bias for recalling threatening stimuli has been observed in anxiety disorders, however only in free recall tasks (Herrera et al., 2017). Despite the lack of evidence for memory bias, we included it as this construct has not previously been explored in relation to FOC but has been found in research assessing the combined cognitive interpretation-memory bias in worry (Feng et al., 2022). In this vein, we considered cognitive biases separately, and the current study was not powered to investigate how biases might interact to predict FOC. According to Hirsch, Clark, and Mathews' (2006) combined cognitive bias hypothesis, biases may work together to maintain psychological difficulties, and it is possible that, for example, memory bias might have been associated with FOC at certain levels of interpretation or attentional biases.

A further limitation of this study is its cross-sectional nature, as we cannot generalise or draw any conclusions regarding the potential for cognitive biases to maintain FOC. Additionally, the anxiety stimuli used in this study for the emotional Stroop task and the scrambled sentences test were taken from previous research and were written in the first person. Therefore, this may have inadvertently allowed these materials to be processed as personally salient and related to upcoming childbirth due to their general nature, e.g., worries about money, which was a GAD stimulus, may have elicited fears regarding economic stability post-partum. This may mean that the potential specificity effect was inadequately explored. We suggest that in future studies, phobic-specific material, such as a fear of heights, be used as a comparison to assess potential specificity effects. Additionally, although we conducted the study at a large maternity hospital with a diverse range of women and birthing people, people in our sample were predominately white, educated, and in a stable relationship. It also appears that this was a particularly fearful sample of women from the general pregnant population. However, as with previous research findings, prevalence of FOC differs depending on which measure is used to assess levels of FOC, which was also found in this sample. Perhaps, individuals who were more fearful were more likely to elect to participate, though the study advert did not mention FOC.

Relatively few studies have addressed cognitive biases in the perinatal period, and none have assessed the three cognitive biases that were used in this study and assessed their relationship with FOC. A major strength of this study was the involvement of experts by experience in creating the cognitive bias task stimuli. The FOC stimuli used in the experimental tasks were created and piloted with women who identified as having high levels of FOC, and who were either pregnant or had given birth in the past year.

Future studies could recruit pregnant women with clinical levels of FOC and compare them with a control group of women with low FOC to investigate between-group differences. Additionally, research could explore the role of any birth-related pre-existing post-traumatic stress disorder as this can be the cause of current FOC and might influence cognitive bias measures through avoidance (Ertan, Hingray, Burlacu, Sterlé, & El-Hage, 2021; Slade, Balling, Houghton, & Sheen, 2022). This may have affected the results of the memory bias task where individuals

may have cognitively avoided threatening childbirth-related information.

Our results add to the knowledge base to further understand FOC presentations. Previously, worry and rumination have been found to be modifiable and, when reduced, to decrease distress (Jones & Sharpe, 2017). Individuals with general anxiety presentation have benefited from cognitive bias modification (CBM), which is an intervention that attempts to modify cognitive processing biases. There are multiple types of CBM, with one being specifically created for interpretation bias. A review of meta-analyses found CBM to be effective in reducing anxiety symptoms by targeting negative interpretation biases (Jones & Sharpe, 2017). Additionally, Hirsch et al. (2021) found that they were able to promote a positive interpretation bias in the group who scored high on worry. However, they did not examine FOC specifically and assessed interpretation bias and not anxiety. Future research could investigate the potential of CBM in the reduction of negative interpretation biases and assess if this has an impact on symptoms of FOC and general anxiety for pregnant women. It could also follow up into the postpartum period.

To summarise, higher levels of FOC were related to a more negative interpretation bias across birth-related and general anxiety-related materials. Higher levels of FOC, as measured by three scales, were also associated with higher levels of low mood, general anxiety, worry, and rumination in women who were at least 12 weeks pregnant. Although our study was cross-sectional in nature, targeting and modifying negative interpretation bias in pregnant women, especially those with high levels of FOC, may be a promising next step when aiming to reduce FOC and anxiety in the perinatal period.

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Declaration of Competing Interest

The authors declare no conflict of interest.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.janxdis.2023.102761.

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