Effects of Women's Stress-Elicited Physiological Activity and Chronic Anxiety on Fetal Heart Rate

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ABSTRACT. This study examined the effects of pregnant women's acute stress reactivity and chronic anxiety on fetal heart rate (HR). Thirty-two healthy third trimester pregnant women were instrumented to monitor continuous electrocardiography, blood pressure, respiration, and fetal HR. Subjects completed the trait anxiety subscale of the State Trait Anxiety Index, then rested quietly for a 5-minute baseline period, followed by a 5-minute Stroop color-word matching task and a 5-minute recovery period. Fetal HR changes during women's recovery from a stressful task were associated with the women's concurrently collected HR and blood pressure changes ($r = .63$, $p < .05$). Fetal HR changes during recovery, as well as during women's exposure to the Stroop task, were correlated with their mothers' trait anxiety scores ($r = .39$, $p < .05$ and $r = -.52$, $p < .01$, respectively). Finally, a combination of measures of women's cardiovascular activity during recovery and trait anxiety scores accounted for two thirds of the variance in fetal HR changes during the same recovery period ($R^2 = .69$, $p < .001$). The results from this study link changes in fetal behavior with acute changes in women's cardiovascular activity after psychological stress and women's anxiety status. This indicates that variations in women's emotion-based physiological activity can affect the fetus and may be centrally important to fetal development. *J Dev Behav Pediatr 24:32–38, 2003.* Index terms: *fetal heart rate, pregnancy, stress, anxiety.*

It has long been established that exposure to toxins, such as alcohol and nicotine, has an impact on fetal development and child outcomes. New evidence indicates that emotion-based variations in pregnant women's physiological activity also may affect the fetus, with implications for the child's future well-being.[1,2–5]

Support for the hypothesis that pregnant women's emotional states affect the developing baby comes from studies on life stress during pregnancy and birth outcomes. High levels of perceived life stress during pregnancy are associated with a significant risk of obstetric abnormalities, specifically lower birth weight and preterm birth.[6–11] For example, a study of 130 women of low socioeconomic status found that greater levels of perceived stress, such as feeling unable to cope and overcome difficulties, con-

tributed significantly to earlier delivery and lower birth weight, even after controlling for medical risk factors such as tobacco and alcohol use, inadequate maternal weight gain, and medical history.[10]

Other chronic mood states during pregnancy also are associated with a range of infant characteristics. For example, babies of women reporting depressive symptoms during pregnancy have been found to be more difficult to soothe shortly after birth[12] and to have poorer reflexes and elevated basal levels of cortisol and epinephrine.[13] Higher ratings of both anxiety and depressive symptoms during pregnancy are associated with reduced high-frequency heart rate variability (HRV) in 3-week-old infants at rest, indicating lower levels of cardiac vagal modulation.[14] In research with adults and children, autonomic nervous system control of cardiac functioning has been identified as a physiological marker of differences in bio-behavioral and emotion regulation. For example, reduced high-frequency cardiac modulation has been found in

12-week-old infants with more negative behavior[15] and in adults who are hostile.[16]

The associations between women's mental health status during pregnancy and infant characteristics likely originate in utero. Notably, despite the obvious limitations to measuring fetal behavior, recent evidence indicates that these relationships now can be directly observed in the fetal period. High levels of self-reported life stress during pregnancy are associated with alterations in fetal cardiac autonomic control similar to those found in newborns of women with heightened anxiety and depressive symptoms.[17] Specifically, pregnant women's reports of life stress are inversely associated with reductions in basal recordings of fetal high-frequency HRV. High levels of anxiety during pregnancy are related to differences in fetal sleep and movement patterns. Fetuses of women with high levels of anxiety spend more time in quiet sleep and move less often in active sleep.[18]

Most of these cited studies detected subtle and medically unremarkable alterations in infant and fetal behavior and physiological functioning linked to women's mental health status during pregnancy. However, as converging data, they suggest that some of the variability in human development may be accounted for by women's emotional states when pregnant. Moreover, these data, which include aspects of fetal and infant arousal patterns (movement, irritability) and stress physiology (cardiac autonomic control), indicate that early alterations in component aspects of biobehavioral and affect regulation may be "programmed" in utero.[19,20] It is believed that stress and other mood-elicited alterations in pregnant women's physiology may bring about changes in the in utero environment, which, over time, may have a cumulative effect, influencing how the fetus develops. Thus, although of relatively small magnitude, the differences in fetal and infant neurobehavior linked to women's emotional states during pregnancy may serve as markers for characteristics that originated in the perinatal period and that have implications for future socioemotional well-being.

Given the emerging data linking women's mood during pregnancy to aspects of fetal and infant functioning, the purpose of this study was to determine "real time" associations between acute psychologically based changes in women's physiology and fetal behavior. In addition, we aimed to explore a possible relationship between a chronic mood state during pregnancy—anxiety—and fetal behavior and to begin to characterize physiological pathways by which women's emotional states may affect the fetus. After having pregnant women complete a self-report measure of trait anxiety, we used a standardized psychophysiology laboratory challenge to elicit from them a stress response while concurrently monitoring maternal and fetal physiological activity. With this approach, we asked the following three specific questions: (1) Are pregnant women's acute, stress-elicited, cardiovascular and respiratory responses correlated with concurrent changes in fetal heart rate (HR)? (2) Does the level of trait anxiety influence pregnant women's stress-elicited physiological activity? and (3) Are differences in fetal HR responses related to their mother's level of anxiety?

METHODS

Subjects

The subjects were 32 nonsmoking, pregnant women with singleton fetuses ranging in gestational age from 32 to 38 weeks who were part of a longitudinal study examining the effects of women's stress responses on the fetus. Women were excluded from the study if there were any maternal or fetal complications including hypertension, diabetes mellitus, suspected fetal growth restriction, or a fetal structural anomaly on ultrasound. None of the subjects reported drinking more than two glasses of wine throughout the entire pregnancy. Fifty-six percent of the sample was Latino, 25% was white, 13% was African-American, and 6% described themselves as Asian or of another ethnic group. For all subjects, English was the primary language. The mean maternal age was 27 years (±5 yr). Sixty-three percent were married, 40% were primiparous, and 88% were working outside the home at least half-time. Because this sample was drawn from an urban hospital and included doctors, support staff, and patients, the average annual family income was above the national average but included women receiving public assistance (mean = $65,475; SD = $46,736). This study was approved by the Columbia Presbyterian Medical Center Institutional Review Board. Informed consent was obtained from each subject.

At the time of testing, the average gestational age was 36 weeks (SD = 1 wk) as determined by a combination of last menstrual period and sonogram. All fetuses were born after 36 weeks (mean = 40 wk, range 36–42 wk) and none were small for date. The average weight at birth was 3371 g (SD = 375).

Procedures

Women made a single visit to the laboratory that began at approximately 11 a.m. and ended at 1 p.m. After a review of the experimental procedures, they completed a self-report measure of anxiety (State Trait Anxiety Index [STAI])[21] and were interviewed briefly about their pregnancy and living situation. Electrodes for electrocardiographic (ECG) and respiration monitoring were attached to the subject's right shoulder, near the left anterior axillary line at the tenth intercostal space and in the right lower quadrant. The subject then was placed in a semirecumbent position. A Finapres blood pressure (BP) cuff (Ohmeda, Englewood, CO) was placed on the middle finger of the nondominant hand, and a numeric keypad for responding to the task was secured in a comfortable position relative to the dominant hand. The subjects could not see the keypad but could identify the keys by feel. An ultrasound transducer (Advanced Medical Systems, Fairfax, VA) was placed on the subject's abdomen to record fetal heart rate (HR). BP readings from the Finapres were checked against a manual sphygmomanometer; adjustments in the Finapres cuff and nondominant hand position were made until the difference between the sphygmomanometer and Finapres readings was less than ±10 mm Hg systolic blood pressure (SBP). The women were given instructions regarding the cognitive task and allowed to practice the task for 1 minute. At the start

of data collection, the subjects were instructed to remain silent throughout the procedures. The subjects rested quietly for a 5-minute baseline and then performed a Stroop color-word task, which was 5 minutes in length, followed by a 5-minute recovery period.

Acquisition and Processing of Physiological Signals

Maternal Heart Rate and Respiration. Electrodes were attached to a heart/respiration monitor (Hewlett Packard 78292A, Avondale, PA), and the analog ECG and respiration impedance waveforms were digitized and collected by a microcomputer. Analog ECG signals were digitized at 500 Hz by a 16-bit A/D card (National Instruments 16XE50, Austin, TX). Specifically written software was used to mark R-waves and create files of RR-intervals. Artifacts in the RR-interval series were defined as values less than 0.4 seconds (HR > 150 beats per minute [bpm]) or more than 1.5 seconds (HR < 40 bpm). When artifacts were detected, the RR-interval file was examined. Artifacts were rejected or corrected after established procedures.[22] For respiration, postacquisition software was used to mark the peaks and troughs of the impedance waveform. These marks were verified by visual inspection and then used to calculate the respiratory rate (RSP).

Maternal BP was measured on a beat-to-beat basis by an Ohmeda Finapres 2300 monitor. The analog pressure waveform was digitized at 250 Hz. SBP and diastolic blood pressure (DBP) values were marked by peak/trough detection software, and errors in marking were corrected interactively.

Instantaneous fetal HR was recorded by an ultrasound transducer (Advanced Medical Systems, IM76), and the analog output was acquired by a microcomputer system.

Maternal Anxiety

Anxiety was assessed using the trait anxiety scale of the STAI,[21] a 20-item, self-report instrument that measures a predisposition to feel ''generally'' anxious throughout one's life. Trait anxiety scores range from a minimum of 20 to a maximum of 80.

Data Reduction and Analyses

Women's cardiovascular and fetal HR baseline data were calculated as the mean values for each of the 5-minute periods (baseline, Stroop, and recovery). Maternal cardiovascular and fetal HR reactivity to the Stroop task were computed as a within-subject change score (Stroop-baseline). Recovery data also were computed as a within-subject change score (Stroop-recovery).

In our previous work, fetal HR during the recovery period was not analyzed independently of the fetal HR responses during the stressor period. However, a review of these data indicated that differences in fetal HR reactivity during recovery were associated with pregnant women's anxiety status.[2] Moreover, recent reports have suggested that data from the recovery period can reveal additional information about individual differences in subjects' physiological activity and response patterns.[23,24] For these reasons, in this report, we separately analyzed data from baseline to stressor and stressor to recovery.

Statistical Analyses

We entered women's four physiological reactivity variables (HR, SBP, DBP, and RSP) simultaneously into regression models to predict fetal HR during the various periods. When the overall model was significant, we examined the results to arrive at the best-fitting model. Simple regression analyses were used to analyze relationships between women's anxiety scores and maternal and fetal physiological variables.

RESULTS

Women's Anxiety Scores

The mean maternal trait anxiety level was 38.2 ± 8.4 (range 24–57). These ratings are similar to the distribution found by Spielberger and Sydeman.[25]

Table 1. Women's Physiological Activity and Fetal Heart Rate at Baseline and Reactivity during Stroop and Recovery

	Baseline		Baseline to Stroop			Stroop to Recovery		
	Mean	SD	Mean	SD	Reactivity Range	Mean	SD	Reactivity Range
Maternal HR (bpm)	94.4	12.0	+3.8	5.4***	−11.3 to +13.7	−4.2	5.3***	−18.4 to +9.5
SBP[a] (mmlHg)	128.7	17.9	+8.0	12.5*	−11.2 to −41.6	−5.3	13.5	−35.8 to +32.2
DBP[a,b] (mmlHg)	80.2	14.5	+4.9	5.9***	−5.8 to +14.9	−1.3	7.2	−12.5 to +13.9
RSP[c] (cpm)	19.2	8.0	+4.1	6.3**	−21.2 to +18.6	−3.0	7.8*	−18.8 to +21.0
Fetal HR (bpm)	143.4	10.3	−0.5	4.5	−10.0 to +7.8	−0.3	4.2	−8.1 to +10.2

bpm, beats per minute; cpm, counts per minute; BP, blood pressure; HR, heart rate; SBP, systolic blood pressure; DBP, diastolic blood pressure; RSP, respiratory rate.
[a]Because of equipment failure, six subjects were missing BP data. Two were missing RSP during Stroop, and one was missing RSP during recovery.
[b]For one subject, BP change values during Stroop and recovery were 3 SD above the mean and excluded from analyses.
[c]One subject's baseline RSP was 3 SD above the mean, as were the subject's stressor and recovery values, all of which were removed from analyses.
*p < .05; **p < .01; ***p < .001.

Manipulation Check: Women's Cardiorespiratory Values at Baseline and Changes During the Stroop and Recovery Periods

Mean baseline and mean changes in maternal heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and respiratory rate (RSP) from baseline to the 5-minute period of cognitive challenge and from stress to recovery are presented in Table 1. Consistent with our previous findings,[2] when averaged across all subjects, the Stroop task led to significant increases in women's HR ($t^{31} = 4.04$, $p < .001$), SBP ($t^{25} = 3.26$, $p < .01$), DBP ($t^{25} = 3.90$, $p < .001$), and RSP ($t^{28} = 3.51$; $p < .01$). Decreases from Stroop to recovery were significant for HR ($t^{31} = 4.5$; $p < .001$) and RR ($t^{28} = 2.18$, $p < .05$) and marginally for SBP ($t^{25} = 2$, $p = .06$), but they were not significant for DBP ($t^{25} = .93$, $p = .36$).

Fetal Heart Rate at Baseline and Changes During the Stroop and Recovery Periods

When averaged across all subjects, there was no significant change in fetal HR during women's exposure to the Stroop task compared with within-subject baseline values ($t^{31} = .60$, $p = .58$). Similarly, across all subjects, there was no significant change in fetal HR during recovery compared with data from the Stroop period ($t^{31} = .36$, $p = .72$; Table 1). As can be seen in Table 1, fetal HR changes during women's exposure to the Stroop challenge ranged from a 10 beats per minute (bpm) decrease to an almost 8 bpm increase. The range of fetal HR change during recovery was -8 to $+10$ bpm.

Fetal Heart Rate and Women's Cardiorespiratory Activity During the Baseline Period

Fetal HR during baseline was unrelated to women's HR, SBP, DBP, and RSP collected during the same 5-minute baseline period ($p > .6$).

Data from the Stroop Period

Changes in Fetal Heart Rate and Women's Cardiorespiratory Reactivity During the Stroop Period. Changes in fetal HR during women's exposure to the Stroop task were unrelated to changes in women's concurrently collected physiological activity (i.e., HR, SBP, DBP, RSP) ($p > .4$).

Changes in Women's Cardiorespiratory Activity During the Stroop Period and Their Anxiety Scores. Changes in pregnant women's SBP, DBP, HR, and RSP in response to the Stroop task were unrelated to their anxiety scores (all $p > .3$).

Changes in Fetal Heart Rate During the Stroop Period and Women's Anxiety Scores. Changes in fetal HR during women's exposure to the Stroop task were positively correlated with women's anxiety scores ($r = .39$, $p < .05$). As women's anxiety levels increased, fetuses showed greater HR increases during their mother's exposure to the stress-eliciting challenge.

Data from the Recovery Period

Changes in Fetal Heart Rate and Women's Cardiovascular Activity During the Recovery Period. The results were significant ($r = .66$, $p < .05$; Table 2) using the four maternal variables (changes in maternal HR, SBP, DBP, and RSP during recovery) to predict fetal HR changes during the same period. We then removed RSP from the model, because it was not an independent predictor of fetal HR, and the model was still significant ($r = .63$, $p < .05$).

Changes in Women's Cardiorespiratory Activity During the Recovery Period and Their Anxiety Scores. Changes in pregnant women's SBP, DBP, HR, and RSP during recovery were unrelated to their anxiety scores (all $p > .7$).

Changes in Fetal Heart Rate During the Recovery Period and Women's Anxiety Scores. Changes in fetal HR during women's recovery from the Stroop task were associated with women's anxiety scores ($r = -.52$, $p < .01$). As women recovered from the stress-eliciting task, fetuses of more highly anxious women showed greater HR decreases.

Changes in Fetal Heart Rate and Women's Cardiovascular Activity During Recovery and Women's Anxiety Scores. A model combining women's HR and BP changes from the recovery period and their anxiety scores explained two thirds of the variance in changes in fetal HR during the recovery period ($r = .83$; $R^2 = .69$, $p < .001$; Table 3 and Fig. 1).

DISCUSSION

Several studies indicate that stress and anxiety during pregnancy are associated with alterations in fetal neurobehavior, such as reduced fetal heart rate variability (HRV) and less time spent in quiet sleep.[17,18,26] Other work suggests that anxiety during pregnancy is related to characteristics of

Table 2. Multiple Regression Model Using Women's Physiological Variables During Recovery to Predict Fetal Heart Rate Changes During the Same Period

	Coefficient	Standard Error	t	p
Changes in women's HR (bpm)	−.437	.165	−2.648	.016
Changes in women's SBP (mm|Hg)	−.309	.100	−3.074	.007
Changes in women's DBP (mm|Hg)	.404	.167	2.425	.026
Changes in women's RSP (breath per min)	−.142	.107	−1.329	.2

HR, heart rate; bpm, beats per minute; RSP, respiratory rate; SBP, systolic blood pressure; DBP, diastolic blood pressure.
Women's HR is heart rate change from the stressor period; SBP and DBP are systolic and diastolic BP changes from the stressor period, respectively.

Table 3. Multiple Regression Model Using Women's Heart Rate and Blood Pressure Changes During Recovery and Anxiety Scores to Predict Fetal Heart Rate Changes During the Same Period

	Coefficient	Standard Error	*t*	*p*
Changes in women's HR (bpm)	−.258	.113	−2.293	.0334
Changes in women's SBP (mmlHg)	−.273	.066	−4.115	.0006
Changes in women's DBP (mmlHg)	.312	.107	2.926	.0087
Raw fetal HR (during Stroop)	−.111	.063	−1.763	.0941
Women's anxiety scores	−.254	.070	−3.625	.0018

STAI, State Trait Anxiety Index; HR, heart rate; bpm, beats per minute; SBP, systolic blood pressure; DBP, diastolic blood pressure.
Women's HR is heart rate change from the stressor period; SBP and DBP are systolic and diastolic BP changes from the stressor period, respectively; fetal HR is the raw heart rate value from the prior period during the Stroop task. Anxiety is trait measure from the STAI.

the in utero environment, for example, elevated stress hormones, which may affect the fetus and subsequent development.[1,27] Results from the current study are some of the first to track a "real time" correlation between changes in women's physiology and synchronous alterations in fetal heart rate (HR). Moreover, the data support our earlier finding of a significant association between women's chronic anxiety and fetal HR responses.[2]

During recovery, although not in response to the Stroop task, changes in fetal HR were associated with women's concurrently collected acute cardiovascular activity that followed a stress-eliciting task. Approximately one half of the variance in the change in fetal HR during women's recovery from the laboratory task was accounted for by the combination of women's HR activity and blood pressure (BP) changes during the recovery period. These data are consistent with the hypothesis of an effect of women's emotion-induced physiological activity on the fetus.

In these results, fetal HR responses during women's exposure to a laboratory challenge were positively correlated with the women's level of chronic anxiety. This finding replicates results from our previous study.[2] In addition, in this report, there was an inverse relationship between changes in fetal HR during the recovery period and women's anxiety status, indicating that the more anxious the woman, the greater the likelihood that the fetal HR decreases after the termination of the stressor period. We investigated the possibility that the association between fetal HR change during recovery and women's anxiety status is not an independent association but simply the inverse of the positive relationship seen between fetal HR changes from baseline to the stressor period and women's anxiety scores. In a regression model that used women's anxiety scores to predict fetal HR during recovery, adding the fetal HR change from baseline to stress was not a significant component predictor of the recovery change model. However, the significance of the direction of the association remains unclear. Perhaps, after completion of the stressor, anxious women withdraw some input to the fetus that initiates their HR decrease. This finding warrants further study.

When women's acute cardiovascular activity after stress and their chronic anxiety status were combined in a model to explain changes in fetal HR during the recovery period, the variables accounted for two thirds of the variance in the fetal HR responses. That is, measuring the mother's psychologically based cardiovascular reactivity, as well as her chronic anxiety, accounted for a large portion of the variance in fetal HR responses.

It is unclear why changes in fetal HR were associated with women's cardiovascular responses during recovery but not during the Stroop task. However, there are several possible explanations. Perhaps the association during recovery is dependent on the time course of humoral processes, which may not yet be present during the Stroop task. Alternatively, perhaps fetuses are affected by women's cardiovascular changes after some threshold of exposure, defined by time, or the frequency of alterations, and that threshold was not reached during the stressor period but was reached during recovery. It is also possible that 10 to 15 minutes into the laboratory study, during which there is perturbation to the in utero environment via women's cardiovascular and respiratory activity, fetuses are in a different sleep state and consequently more reactive to any type of stimulation. Finally, during the stressor period, there may be a relationship between women's reactivity and fetal HR, but it is with an unmeasured variable, such as changes in women's muscle tone, respiration amplitude, or BP variability.

In the regression model using changes in women's HR and BP during the recovery period to predict concurrently collected changes in fetal HR, for both BP variables there was a significant correlation with the fetal response, yet the correlations had opposite signs. Change in systolic blood
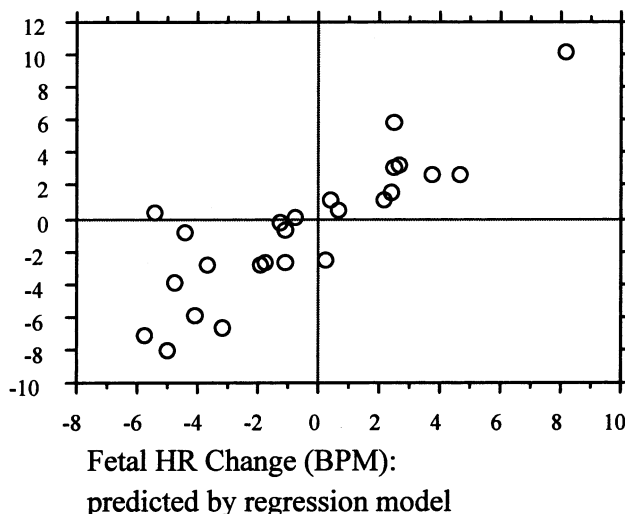

FIGURE 1. Fetal heart rate (HR) change (beats per minute [bpm]): Stroop to recovery predicted versus observed values.

pressure (SBP) was negatively correlated with fetal HR change, whereas change in diastolic blood pressure (DBP) was positively correlated with fetal HR change. This indicates the possibility that changes in pulse pressure might be positively correlated with fetal HR changes and would account for a similar portion of the variance as SBP and DBP in combination. This, in fact, was the case ($r = .62$, $p < .01$), and the finding is consistent with our idea to investigate the magnitude of maternal responses in relation to fetal behavior, as well as the direction of maternal reactivity. In future studies, we plan to investigate the possible influence of women's pulse pressure activity on fetal HR.

We did not find any significant associations between women's anxiety status and their own cardiovascular and respiratory activity; thus we did not identify a physiological pathway by which women's chronic anxiety might affect fetal HR during the stress-eliciting task and the recovery period. The lack of an association between stress-elicited changes in women's BP and anxiety status is in contrast with our previous report,[2] as well as with data from other laboratories (e.g., Young et al[28]), in which pregnant women's BP responses during the laboratory challenge period were significantly related to their anxiety scores. These conflicting results may be due to the fact that in our previous work, some subjects were administered a Stroop task and others a mental arithmetic challenge. As we have found that Stroop, compared with arithmetic, leads to greater cardiovascular reactivity from pregnant women,[29] it may be that in this study, in which all women were administered the Stroop task, the effectiveness of the stressor masked the range of responses associated with anxiety status.

In this study, fetal HR responses revealed during women's recovery from a laboratory challenge were correlated with women's acute cardiovascular activity after a stressor. Such findings raise the possibility that cumulative exposure to particular patterns of emotion-induced physiological activity over the course of gestation may influence fetal development. This formulation is consistent with the finding that fetuses of women experiencing high degrees of life stress throughout pregnancy have lower HRV.[17]

Moreover, our results also indicate an influence of women's anxiety on fetal HR. This association indicates the possibility that there may be a trait-like difference in fetal HR activity that is associated with a chronic emotional state in pregnant women. Although this could be an inherited trait, the findings here, which indicate the possible acute transmission of women's stress-elicited cardiovascular activity to the fetus, support the conceptualization that throughout pregnancy, qualities of the in utero environment (such as the repetition of anxiety-based alterations in the women's physiological activity) may influence fetal development and contribute to the emergence of individual differences in the fetus.

There are several limitations of this study. Although numerous investigators rely on the trait subtest of the State Trait Anxiety Index (STAI) to measure chronic anxiety, the instrument is a one-time self-report test that asks subjects to reflect on how they "feel most of the time." Thus, subjects' ratings of trait anxiety can be easily influenced by current emotional states. In future work, we plan to better characterize women's mood throughout the course of pregnancy by conducting a thorough psychiatric interview during the second trimester and gathering ratings of mood throughout pregnancy.

In addition, the sample included women from a range of socioeconomic status and ethnic backgrounds. Although this improves the generalizability of our results, differences in physiological stress reactivity are known to be associated with these demographic variables. We would expect such findings in our study. However, because our sample size was small, none were detected. In future studies, we will recruit a larger sample to investigate these possible influences.

Previously, we found that an aspect of fetal behavior is related to women's anxiety status.[2] Findings from this report are some of the first ever to determine a "real time" association between fetal HR and women's psychologically induced changes in cardiovascular activity. Taken together, the findings are consistent with a model in which differences in biobehavioral development may be, in part, shaped in utero. Longitudinal studies focusing on fetal, infancy, and childhood periods will help determine whether fetal characteristics associated with women's emotional states during pregnancy are transitory or, in fact, indicative of a process leading to trait-like characteristics that have implications for the child's long-term health and development.

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