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Published in:
Journal of Prenatal & Perinatal Psychology and Health

Publication date:
1990

Pre- and Peri-Natal Psychology, 5(2), Winter 1990

The Influence of Maternal Emotions During Pregnancy on Fetal and Neonatal Behavior

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ABSTRACT: The following problems are the leading questions of our research project: (1) Can the influence of maternal emotions upon fetal behavior be established in the prenatal period, using real-time ultrasound echography and cardiography? (2) Is the prenatal influence, established in the prenatal period, reflected in the neonatal behavior? And can we find significant correlations between maternal emotions during pregnancy on the one hand and neonatal and infant behavior—e.g. neonatal neurological state and behavioral states organization, feeding behavior, mother-infant-interaction, infant temperament—on the other hand?

Results are as follows: (1) A longitudinal study of 30 women out of a larger group of 70 nulliparous women revealed that maternal state anxiety during echographic recording (120') was significantly correlated with fetal behavior. Moreover it was found that fetal behavior was sensitive to the influence of maternal chronic anxiety (trait anxiety) during pregnancy. (2) Results on the subgroup of 30 women and their babies seem to suggest a certain degree of continuity between fetal and neonatal movement patterns and further indicate that the prenatal influence is reflected in neonatal behavior. Analysis of the follow-up data (n = 70) revealed other effects of maternal emotions (studied during each pregnancy trimester and at the 1st, the 10th and the 28th week after birth) on infant behavior (observed at the 1st, the 10th and the 28th week).

It has been suggested that maternal stress and emotions during pregnancy may affect fetal and neonatal behavior and development. This hypothesis has become the subject of scientific inquiry during the last decades (Carlson & LaBarba, 1979; Istvan, 1986; Van den Bergh, 1983, 1988), but interest in this topic already had a long history by that time.

Regarding the effect of maternal emotions on fetal behavior, the observation has been made (apparently for the first time in 1867 by Whitehead) that mothers under severe emotional stress tend to have hyperactive fetuses (Ferreira, 1965; McDonald, 1968; Montagu, 1962;

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Wolkind, 1981). Sontag (1941) reported similar observations in eight cases in 1941. Other case reports showed that when the mother is anxious (Copher & Huber, 1967) or emotionally upset (Eskes, 1985) the fetus show tachycardia. In 1980, during an earthquake in southern Italy, Ianniruberto and Tajani had the opportunity to examine 28 panic stricken women (18–36 weeks pregnant) with ultrasonography. All fetuses showed intense hyperkinesia which lasted from two to eight hours and their movements were numerous, disordered and vigorous. Zimmer et al. (1982) concluded from their study that far less intense maternal emotional conditions (e.g. listening to music) also can affect fetal behavior. Field et al. (1985) compared a group of women who received video and verbal feedback during ultrasound examination to a no-feedback group. They concluded that the feedback appeared to reduce pregnancy anxiety and fetal activity. We have been unable to find controlled studies on the effect of maternal emotions on fetal behavior, in which fetal behavior was observed in a direct and standardized way and for a sufficiently long period.

With regard to the influence of maternal emotions during pregnancy on neonatal (and postnatal) behavior, Sontag (1941, 1966) observed that infants of emotionally disturbed women tend to have high activity levels following birth. These infants have also been characterized as irritable, poor sleepers and prone to gastrointestinal difficulties (Dodge, 1972; Ferreira, 1960; Turner, 1956 and see Carlson & LaBarba, 1979). Ottinger and Simmons (1964) reported that two to four days postpartum, infants of high anxious pregnant women cried significantly more than infants of low anxious pregnant women. Farber et al. (1981) observed that such babies showed a deviant behavior on the Brazelton Neonatal Behaviour Assessment Scale. According to Vaughn et al. (1987) these babies are perceived by their parents as having a difficult temperament. Davids et al. (1963) found that compared to infants of low anxious pregnant women, infants of high anxious pregnant women scored significantly lower on the Mental Scale of the Bayley Scales of Infant Development. They also scored lower on the Motor scale, though this difference was only marginally significant.

We studied the effect of maternal emotions during pregnancy and investigated the following two questions: (1) Can the influence of maternal emotions upon fetal behavior be established in the prenatal period, using real-time ultrasound echography and cardiography? (2) Is the prenatal influence, established in the prenatal period, reflected in the neonatal behavior? And can we find significant correlations between maternal emotions during pregnancy on the one hand and neonatal and infant behavior—e.g. neonatal neurological state and behavioral state organization, feeding behavior, mother-infant-interaction, infant temperament—on the other hand?

With regard to the first question, a controlled study on ten healthy near term pregnant women (Van den Bergh et al., 1989) revealed that acute emotions, induced by showing a film of normal delivery had no effect on fetal behavioral state organization nor on fetal motor activity. However, a significant correlation ($p < .01$) was found between situational anxiety (mean state anxiety), which occurs in women during echographic recording (120'), and mean motor activity level of the fetus. A second study has been conducted to corroborate this significant correlation on a larger sample and to study the influence of more chronic emotions during pregnancy on fetal behavior. This study was part of a larger, longitudinal study in which we also tried to answer the second question.

In this paper we shall briefly introduce the longitudinal study. Our attention will mainly be directed to the presentation of the results obtained on the subsample within this larger study on which the influence of maternal emotions during pregnancy on fetal (Question 1) and neonatal (Question 2) behavior has been studied. Some other results of the follow-up will also be presented.

Method

The *longitudinal study* was conducted on 70 healthy nulliparae, 18 to 30 years old and with varying levels of anxiety. Their emotions were studied during each pregnancy trimester and in the 1st, 10th and 28th week after birth, using psychological tests. The State Trait Anxiety Inventory (STAI, Spielberger et al., 1970) was taken on each occasion. This standardized questionnaire differentiates between an anxiety state (that reflects current tension or apprehension and is fluctuating) and an anxiety trait (of a characterological nature, a disposition, anxiety proneness). During pregnancy other tests included the Pregnancy Anxiety Scale (Shaefer & Manheimer, 1960; Taylor, 1980), the Pregnancy Symptom Checklist (Fagley, 1982; Kumar et al., 1984), the Maternal-Fetal Attachment Scale (Cranley, 1981), a Life Event Scale (Barnett et al., 1983; Chalmers, 1981), a Social Support Questionnaire (Norbeck et al., 1981, 1983), a Copinglist (Schreurs et al., 1984) and a Personality Questionnaire (Wilde, 1970) (see Van den Bergh, 1988.) After birth, the women answered questionnaires regarding the birth experience (Keller, 1985) and the behaviour (feeding, sleep . . .) of the neonatus (Broussard, 1979; Daniëls et al., 1984). In the 10th week after birth women filled out the Carey and McDevitt questionnaire regarding their baby's temperament (Carey, 1970). The same questionnaire was readministered to the mothers at 28 weeks after birth. They also completed another temperament questionnaire (Bates et al., 1979) and indicated the problems they had experienced with their seven month old baby.

In the 1st and 28th week after birth the baby's were studied with the use of standardized observation tests (the neonatal neurological examination introduced by Prechtl (1977) and the Bayley Scales of Infant Development (Bayley, 1969) respectively. In the 1st and 10th week after birth, feeding behavior (Daniëls & Casaer, 1985) and mother-child interaction were observed during feeding, using the AMIS (Assessment of Mother-Infant Sensitivity; Price, 1982). Obstetrical data were also gathered and Prechtl's optimality score (Prechtl, 1967, 1980; Michaëlis et al., 1979) was used in the analysis of these data.

The data obtained at the different measurements points were reduced with factor-analysis and component-analysis. The associations between these newly created data sets were then explored using canonical correlation techniques and Pearson correlations.

Fetal observations were carried out on a *subgroup of 30 women* with uneventful pregnancies and subsequent deliveries. Fetal behavior (general movements, eye, head, mouth, breathing and limb movements) was continuously observed in a standardized way (see de Vries et al., 1982) during a 2 hr period (16 to 18 hr) using two ultrasound units (Toshiba SAL 50A and SAL 10A). One real-time B-scanner was placed on the fetal face in a parasagittal position; the other was used to visualize the body movements. Both images were videotaped. Data on occurrence and duration of all the movements were encoded (online or offline) with the use of event markers and were stored on a personal computer (Apple IIe) for statistical analysis. Fetal HR was recorded using a HP 8040 cardiotocograph. Immediately before and after these recordings, carried out at 36–37 weeks of pregnancy, the women also completed the State Anxiety Scale (Spielberger et al., 1970). On the 5th or 6th day after birth a comparable 2 hr observation of neonatal behavior was carried out and analyzed, using the same software specifically designed for this study.

Both *fetal and neonatal behavior were operationalized as behavioral state organization and as motor activity.* Put bluntly, states refer to different patterns of rest and activity. Although behavioral states have an important meaning for the assessment of the maturation and integration of the nervous system, they were used just as a measure of behavior in this study. "State is a centrally coordinated mode of neural activity which expresses itself in a variety of variables. These variables changes their properties simultaneously at the onset and end of a particular state epoch. These epochs are by definition stable. Their arbitrarily chosen minimum length is 3 min" (Nijhuis et al., 1982, p. 194). Behavioral states can be described using a simple vector classification system (see Tables 1 and 2).

In the neonatus five states are distinguished (State 1 to State 5). The four states of the fetus are called State *1F* to State *4F*. In the normal

Table 1
Vector Classification of Behavioral States in the Neonatus (Prechtl & O'Brien, 1982)

	State Variables			
States	*Eyes open*	*Respiration regular*	*Gross movements*	*Vocalization*
State 1	−1	+1	−1	−1
State 2	−1	−1	0	−1
State 3	+1	+1	−1	−1
State 4	+1	−1	+1	−1
State 5	0	−1	+1	+1

Signs: + = true; −1 = false; 0 = true or false.

Table 2
Fetal State Criteria Represented as Vectors (Nijhuis et al., 1982)

	State Variables		
States pattern	*Body movements*	*Eye movements*	*Heart rate*
State 1	incidental	absent	A
State 2	periodic	present	B
State 3	absent	present	C
State 4	continuous	present	D

Heart rate pattern (HRP) A = stable with a small oscillation bandwidth; HRP B = a wider oscillation bandwith than HRP A and frequent accelerations during movements; HRP C = stable but with a wider oscillation bandwidth than HRP A and no accelerations; HRP D = unstable with large and long-lasting accelerations frequently fused into a sustained tachycardia.

human fetus definite behavioral states are present at a postmenstrual age of 36–38 weeks. Before this time state variables accidentally can co-occur simultaneous. Periods during which this happens are called 'periods of co-incidence 1F to 4F'. These periods resemble states but lack the synchronized onset and end. They are frequently shorter than the minimum duration of states (Nijhuis et al., 1982, p. 194).

In our study *behavioral state organization* was expressed as (1) percentage of observation time for Coincidence 1F through 4F (fetus) and State 1 through 5 (neonatus) and (2) mean duration of enclosed epochs of these coincidences and states.

Both *fetal and neonatal motor activity* were operationalized (1) as the percentage of time that general movements are present and (2) as the percentage of time that head movements are present and (3) as mean duration of general movements. Each of these indices of motor activity were expressed as a function of the entire recording period (total motor activity) as well as a function of each of the four types of coincidence (state dependent motor activity).

RESULTS

To answer **the first question**, the maternal state anxiety scores (obtained before the fetal recordings (acute, situational anxiety) and the trait anxiety scores (one for each pregnancy trimester; chronic anxiety) were correlated with the fetal behavioral measures.

Significant Pearson correlations are presented in Table 3. Positive significant correlations between maternal *state anxiety* and fetal motor activity were obtained (r = .37 to .67, p < .05 to .001), corroborating the results of the first study (Van den Bergh et al., 1989). Additionally, significant correlations were found (1) between maternal state anxiety and fetal behavioral state organization (r = .38, p < .05), (2) between maternal *trait anxiety* and fetal motor activity (r = .31 to .51, p < .05 to .01) and (3) between maternal trait anxiety and fetal behavioral state organization (r = – .30 to .49, p < .05 to .01). These correlations indicate that fetuses of high anxious women show higher levels of activity than fetuses of low anxious women.

To answer **the second question** (reflection of the prenatal influence in neonatal behavior), comparable measures of fetal and neonatal behavior relating to behavioral states and motor activity, were correlated. Significant results are presented in Table 4. The finding that

Table 3
Overview of Significant Pearson Correlations with Regard to Question 1

	State Anxiety[a] (before recording)	Trait Anxiety[b] (1st, 2nd, 3rd pregn. trim)		
Fetal behavioral states				
1. % of periods 4F	.38*	.44**	.49**	.39*
2. mean enclosed ep1F		−.41*	−.47**	−.30*
Fetal motor activity				
1. % of general movements:				
–during entire recording	.38*		.33*	
–during periods 4F	.47**	.45**	.44*	.38*
2. % of head movements:				
–during entire recording		.35*	.35*	.31*
–during periods 4F	.67***	.51**	.38*	.49**
3. mean duration of GM:				
–during entire recording	.45**	.44**	.47**	.35*
–during periods of 2F	.43**	.36**	.37*	
–during periods of 4F	.37*	.34*	.48**	.33*

[a] $n = 28$, [b] $n = 26$ to 28
* $p < .05$. ** $p < .01.0$. *** $p < .001$.

fetal head movements (rather than general movements) are correlated with neonatal head and general movements (Table 4 below) is the most consistent result across different states.

Different Linear Structural Relations (LISREL; Jöreskog & Sörbom, 1981) models on the combined effects of maternal anxiety and fetal behavior on neonatal behavior were tested. The models in which maternal anxiety had only an indirect effect on neonatal behavior (namely by modifying fetal behavior; see Figure 1) produced the best fit to the data. In general, the results with regard to our two questions were corroborated by the LISREL models.

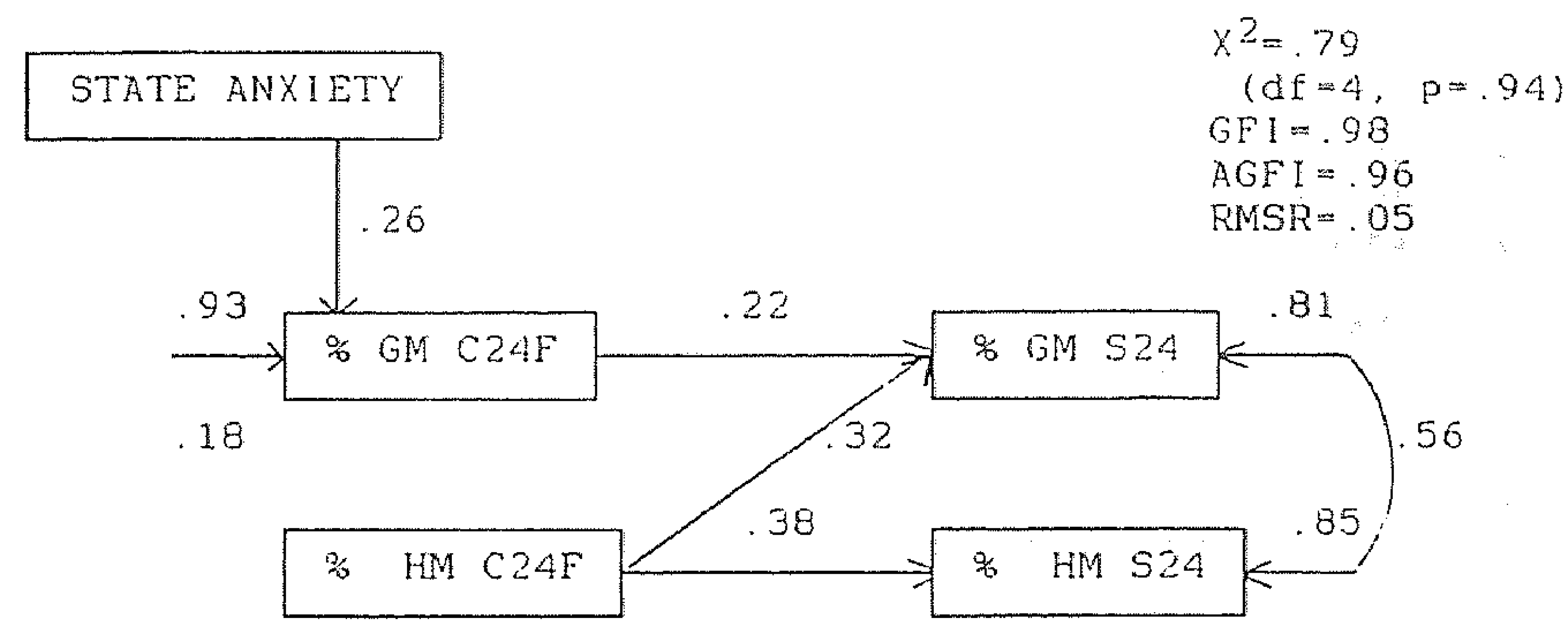
The results of the *follow-up study* we present here are mainly based on the Pearson correlations calculated between the maternal state and trait anxiety scores obtained for each pregnancy trimester and the different measures of neonatal and postnatal behavior. Compared to infants of low-anxious women, infants of high anxious women cried more ($r_{70} = .29$, $p < .05$) and changed more frequently from one

Table 4
Overview of Significant Pearson Correlations
with Regard to Question 2[a]

	Behavioral States			
	1 & 1F	*2 & 2F*	*4 & 4F*	*Total*
Behavioral states				
1. mean encl. epoch	.47*			
Motor activity				
1. % of GM	.34*		.33*	
2. % of HM		.56**	.49**	.53**
3. mean durat. GM			.67***	
4. % GM(f) & %HM(n)			.43*	
5. % HM(f) & %GM(n)		.41*	.40*	.51**

Note. Significant correlations between corresonding measures of fetal and neonatal behavior are given first; cross-correlations between fetal (f) and neonatal (n) measures of general movements (GM) and head movements (HM) follow (motor activity 4 and 5.)
[a]$n = 27$.
*$p < .05$. **$p < .01$. ***$p < .001$.

Figure 1
LISREL model relating state anxiety in pregnancy
to fetal and neonatal behaviour



df = degrees of freedom; GFI = Goodness of Fit Index; AGFI = Adjusted Goodness of Fit Index; RMSR = Root Mean Square Residual. State A = State Anxiety, momentary anxiety; % GM = percentage general movements; % HM = percentage head movements; C24 = periods of coincidence 2F and coincidence 4F (fetus). S24 = periods of state 2 and state 4 (neonatus).

behavioral state to another ($r_{70} = .39, p < .005$) in the neonatal period. At ten weeks these infants were more frequently diagnosed as infants with a difficult temperament ($r_{59} = -.35, p < .01$). Seven months after birth high anxious women more frequently indicated the following behaviors of their children as being a problem for them: being too active ($r_{56} = .39, p < .005$), being hungry ($r_{60} = .31, p < .05$). They perceived their infants as infants having a difficult temperament ($r_{59} = .45, p < .001$). Infants of high anxious and low anxious women obtained comparable scores for the neurological examination, the feeding observation behavior, and the Bayley Scales of Infant Development.

DISCUSSION AND CONCLUSION

With regard to Question 1, it may be concluded from our results that the influence of maternal emotions has been established in the prenatal period. Maternal emotions have a small but significant effect on occurrence and duration of fetal motor activity. Fetuses of high anxious women tend to be more active than fetuses of low anxious women. This relationship could be established using both acute situational anxiety and more chronical anxiety as indices of the mother's emotional state.

Regarding Question 2 we can say that the prenatal influence is reflected in neonatal behavior. Indeed our data seem to suggest a certain degree of continuity between fetal and neonatal behavior. Active fetuses tend to have a high activity level after birth.

We can also conclude that maternal emotions during pregnancy are correlated with neonatal and infant behavior. These correlations indicate that children of high anxious pregnant women have gastrointestinal problems, cry frequently and are perceived as having a difficult temperament. They do not however have a deviant score on the neurological examination, on standardized observations of a feeding situation and on the Bayley Scales of Infant Development.

Our results should be interpreted with caution. Although the correlations are significant, they are small and much of the variance remains unexplained. A clear explanation of the findings and the underlying mechanisms is (still) lacking. We presume that the influence of maternal emotions on fetal behavior is mediated by hormonal factors, but the exact physiological background is unclear.

The findings on neonatal and postnatal behavior can be explained in different ways. One explanation holds that these behaviors are the reflection of the prenatal influence of maternal anxiety during pregnancy. A second interpretation could be that anxious women have more pregnancy and delivery complications and that these have an adverse effect on the infant's behavior. A third possibility could be that anxious women have a negative perception of their child. Fourthly we could say that women who are anxious during pregnancy remain anxious after pregnancy and that their postnatal anxiety influences the behavior of the child. A fifth factor can be heredity. On the basis of our data we cannot test the plausibility of these different interpretations. Most probably they are all at play.

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