Relations between Maternal Stress and Attention to Emotion in Infancy

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Abstract

The purpose of this study is to examine the connection between infant attention to emotional faces and maternal stress associated with environmental factors. As an initial test, the study explores maternal stress with self-reported characteristics of their environment. We examined infants' emotional attention to angry, happy, and neutral faces captured via eye tracking at 4-, 8-, 12-, and 18- months. The data indicate that there were no significant effects independently due to emotion or stress at the younger ages of 4 or 8 months. However, by 12 months, infants with high stress mothers spent more time looking at the faces, across emotions. In addition, across the sample, infants spent less time looking at neutral faces, relative to happy and angry faces. At 18 months, infants looked the most at angry faces, versus happy and neutral. Over time, there is more attention specifically to angry faces. Follow up work will need to examine infants at a larger scale and across more trajectories to refine the potential relation between maternal stress and attention to emotion in infancy.

Introduction

Researchers have examined both typical trajectories, and individual differences, for recognizing and interpreting both threatening and non-threatening faces in the first years of life. Both humans and non-human animals use facial emotion to interpret their surroundings to determine if it is or is not harmful (Nystrom & Ashmore, 2008). Interpreting faces tends to emerge at an early age in humans. For example, infants as young as 6 six weeks begin to recognize and distinguish faces. Furthermore, around 6 months typically developing infants can start to recognize different emotions on faces (Charlesworth & Kreutzer, 1973; Grossmann, 2010). Infants learn from their surrounding environment, which is typically shaped by their parents beginning in the first year of life, happening in tandem with the development of facial emotions processing. This developmental window from birth to approximately 24 months can be sensitive to multiple factors, including parental emotions, health, and stress. The impact is particularly acute with respect to the influence of maternal characteristics and behaviors on infants. Early motherhood can be a stressful time and this stress can produce a spillover effect on the child. For example, the stress can overflow to the child in forms of anger or neglect (Williamson et al., 2013). The spillover may result in the infant processing emotional faces differently and paying more or less attention to threatening facial expressions.

Maternal stress can originate from multiple sources, including environmental stress. It is important to research the effect of maternal stress from environmental factors and how it can influence infant emotional facial attention and recognition. With better research in this domain, interventions can be put into place to benefit the mother and child. Stress is a mental or emotional tension resulting from adverse circumstances. Environmental factors such as socioeconomic status (SES), crime, discriminatory treatment due to race can have an effect on individuals in many ways. The pervasive impact of stress, in turn, may result in both physical and mental health issues for individuals (Yaribeygi et al., 2017). Conduits for the environment can be captured by characterizing the neighborhood. Neighborhoods can influence individuals functioning and development in both positive and negative ways. The various environmental factors of the neighborhood can lead to stress across individuals. Here, we focus on the specific impact on mothers and potential spillover on infant attention.

Environmental stressors experienced by pregnant women can place an added stress on the fetus resulting in, but not limited, to miscarriages, premature births, and low birth weight (Knackstedt et al., 2005). Postnatally, maternal stress also influences infant development across multiple domains. Studies have shown that mothers who report they have high stress from being mothers due to lack of social support, parenting competence, and depression also report that children rate lower on dimensions of mastery motivation (Sparks et al., 2012). Maternal traumatic experiences in pregnancy may impact their offspring's temperament, especially negative affectivity (Rodríguez-Soto et al., under review). At one extreme, Post-Traumatic Stress Disorder (PTSD) can arise when an individual is exposed to an extreme stressor or traumatic event (Yehuda, 2002). For example, Yehuda et al. (2005) found that mothers and babies who were exposed to elevated stress after the 9/11 attacks on the World Trade Center had lower cortisol levels. Cortisol is a hormone that is responsible for threat and fight or flight (Terburg et al., 2009), suggesting that these mother-child pairs had lower levels of arousal to threat.

Increased stress is also associated with substance use in pregnancy. Infants who were prenatally exposed to substances had worse birth outcomes followed by increases in both internalizing and externalizing behaviors by the age of 5 (Lin et al., 2018). These findings support the idea that maternal stress can have a direct effect on infants and their development. The current study will highlight the idea that maternal stress from environmental factors may be associated with infants' development, specifically patterns of attention to emotional cues in the first years of life. These environmental factors can be captured by characterizing the neighborhood a child is embedded in. There are many demographic and socioeconomic factors that contribute to maternal stress (Leach et al., 2018). For example, racial socialization is a neighborhood factor that captures "the nature of race status as it relates to: (1) personal and group identity, (2) intergroup and interindividual relationships, and (3) position in the social hierarchy" (Caughy et al., 2017). Caughy and colleagues (2008) studied neighborhood racial composition noting if the given area had over 80% of either African American or European American inhabitants. They found that high neighborhood economic disadvantage is correlated with poorer child behavioral and cognitive outcomes because of racial disparities.

Neighborhood-related factors such as childcare and family support, can also contribute to maternal stress. As noted above, maternal stress can have a wide-ranging impact on infant development. One core domain impacted by stress may be attentional patterns to emotion. Mothers handle stress in various ways, which can include visible hostility towards or around their children. Maternal stress can translate into the mother-child relationship and parental efficacy (Mi-Sook & Hyuk-Jun, 2005).

Currently, mothers still engage in the lion share of direct infant care in the first years of life, bridging the impact of maternal stress in pregnancy to the child's first years. When pregnant, mothers who report high levels of emotion dysregulation had newborns with lower attention and arousal levels (Ostlund et al., 2019). However, in the same study, infants who scored higher on the arousal scale were more sensitive to the environment. High levels of stress in parents are also associated with infants being less alert to angry faces (Burris et al., under review). The decrease in attention to the angry faces may be caused by the infants' conditioned response to repeated exposure to angry or distressed faces. Thus, maternal stress from possible neighborhood/environmental factors can contribute to patterns of attention to emotional faces by altering daily environmental input from caregivers.

The detection of facial emotion can be altered by the infant's environment. Infants with highly anxious mothers show greater attentional bias toward threat (Morales et al., 2017). This was evident in longer attention toward angry face stimuli. Mothers who have high stress are less interactive with their child (Feeley et al., 2011) and those interactions may take on a more negative tone. Infants may engage or disengage with certain stimuli based on what they are conditioned to seeing in their daily lives. Stable patterns of emotional facial attention may emerge as early as 6 months. (Charlesworth & Kreutzer, 1973). In the second half of the first year of life, babies are less likely to engage with happy and neutral faces compared to negative faces (Pérez-Edgar et al., 2017). However, when infants are conditioned to not experiencing happy faces, we predict they engage with happy faces more often. Infant attention patterns may also generalize beyond emotional faces. For example, threats represented by animals (e.g., snakes) also pull for greater attention. Thus, early patterns of attention may ripple across multiple domains of processing and impact multiple domains of functioning.

The purpose of the current study is to examine the connection between infant emotional facial attention and maternal stress associated with environmental factors. A diverse sample will be used to capture a wide range of individual experience and minimize potential bias due to homogenous samples. Specifically, we will look at infants' emotional attention to angry, happy, and neutral faces captured via eye tracking. We anticipate that infants who have mothers who are exposed to more environmental factors known to contribute to maternal stress will display less attention on angry faces vs. happy and neutral faces compared to infants with less stress exposure. We predict that infants in more stressful environments will have been exposed to angry emotions more often, which will lead to less interest in the negative emotions. These data could inform interventions to help decrease environmental and parental spillover effects on infant perceptual and socioemotional development.

Methods

Participants

Infant and caregiver pairs were recruited for a larger study of infant socioemotional development through various strategies including baby registers, database, visiting parenting class and word-of-mouth (Pérez-Edgar et al., 2021). In the end three hundred and fifty-seven infant and caregiver pairs were enrolled in the sample. Most of the infant and caregiver pairs were enrolled when the infants were 4-months. The majority were recruited from State College, PA (n=167), followed by Newark, NJ (N=109) and Harrisburg, PA (N= 81). Caregivers identified 180 of the infants as white, 58 as African American/Black, 9 as Asian, 78 as Latinx, 27 as mixed race and 5 declined to provide the information. For the current study, we will leverage data from the first 4 data collection waves: 4, 8, 12, and 18 months.

Measures

Infant Overlap. Infants completed a version of a classic overlap task to assess infants' ability to disengage from emotional faces. Consistent with the calibration procedure, stimuli were presented using the Experiment Center. Infants were presented with up to 30 experimental trials, ending either when all trials were completed or when the infant could no longer attend to the task. Each trial was initiated when the infant's attention was on a video clip presented centrally on the screen, which was triggered either when the infant fixated for at least 100ms or when the experimenter determined that the infant was looking at the video clip. If the participant did not attend to the center of the screen, the slide advanced after 10000ms. Following was a central face sampled again from the NimStim face set for 1000ms. Ten actors (5 male) provided neutral, happy, or angry, closed mouth images. Facial stimuli were approximately 12 cm x 8cm and the visual angle of each face was 11.42° (H) x 7.63° (W). Following the presentation of the face, a checkerboard stimulus then appeared in either the left or right periphery of the screen adjacent to the face (20.78° visual angle) for 3000ms. The checkerboard was 12 cm x 2.5cm, 11.42° x 2.39° visual angle. This progression of stimuli was concluded with a 1000ms ITI, which was a blank screen. No consecutive trials were identical in terms of face and probe placement.

Confusion, Hubbub, and Order Scale (CHAOS). The CHAOS is a 15-item survey designed to assess 'environmental confusion' (high levels of noise, crowding, traffic pattern) in the home. It was collected at the 4-, 8-, 12-, 18-, and 24-month time points. Each item is a statement (e.g., *There is very little commotion in our home*) with parents responding on a four-point Likert scale (1 = *Very much like your own home*, 2 = *Somewhat like your own home*, 3 = *A little bit like your own home*, 4 = *Not at all like your own home*). A total score is generated by summing all of the items.

Parent Daily Hassles Survey (PDHS-R). The PDHS-R is a 20-item survey designed to assess the frequency and intensity of daily hassles experienced by parents [47]. It was collected at the 4-, 8-, 12-, 18-, and 24-month time points. Each item describes an event that may routinely occur in families with young children (e.g., being nagged, whined at, complained to) and parents note the frequency (rarely, sometimes, a lot, or constantly) and then how much of a 'hassle' the events have been for them within the past 6 months using a 1 to 5 scale. Responses are not child-specific, and the survey is not designed to capture relational difficulties with any particular child. The hassles scale can be used in two different ways: totals of frequency and intensity scales, or by deriving 'challenging behavior' and 'parenting tasks' scores from the intensity scale. The challenging behavior total score is obtained by summing seven items from the intensity scale scores and the parenting tasks scale is obtained by summing eight items from the intensity scale.

Results

The current analysis focuses on the relation between maternal self-reported stress and infant attention to emotion faces at 4, 8, 12, and 18 months. In order to create stable measures of stress, each of the subscales for the PDHSR were standardized and then averaged into a single score for each time point. The CHAOS score was also standardized. The PDHSR and CHAOS were then averaged to create a single Stress score at each time point. As can be seen in Table 1, the sample size varied considerably across testing times. Missing data were due to either infant inability to complete the task, missing questionnaire data, or family study withdrawal. Table 2 presents the intercorrelations between the Stress scores and infant attention values.

Table 1. Mean, standard deviation (SD), and number (N) for the maternal self-reported stress and infant attention to happy, angry, and neutral faces at 4-, 8-, 12-, and 18-months.

	Mean	SD	N
4 months			
Maternal Stress	0.0004	0.86446	241
Neutral	1476.26	716.98	116
Angry	1376.92	734.73	116
Happy	1402.57	731.07	116
8 months			
Maternal Stress	-0.0001	0.88854	205
Neutral	1499.16	544.72	173
Angry	1452.81	581.29	173
Happy	1508.13	586.57	173
12 months			
Maternal Stress	-0.0057	0.87839	165
Neutral	1269.41	542.41	131
Angry	1352.60	528.26	131
Happy	1358.43	552.84	131
18 months			
Maternal Stress	0.0033	0.89100	175
Neutral	1492.17	594.52	107
Angry	1646.81	574.73	107
Happy	1487.41	624.43	107

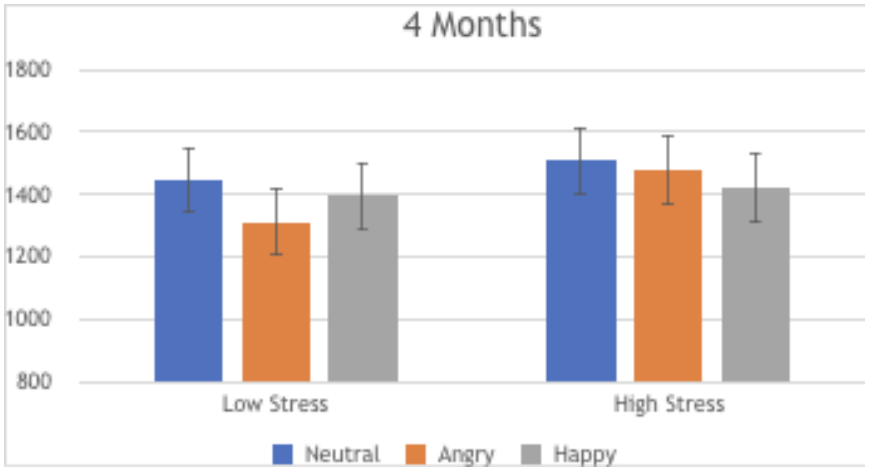
Table 2. Intercorrelations between maternal self-reported stress and infant attention to happy, angry, and neutral faces at 4-, 8-, 12-, and 18-months. Number (N) is reported in the parentheses.

	Stress4	**Stress 8**	**Stress 12**	**Stress 18**
Neu4	0.056 (87)	0.122 (61)	-0.025 (57)	0.017 (57)
Ang4	0.080 (87)	0.118 (61)	0.063 (57)	0.123 (57)
Hap4	-0.002 (87)	0.172 (61)	0.008 (57)	-0.040 (57)
Neu8	-0.03 (120)	0.146 (130)	0.110 (97)	-0.103 (105)
Ang8	0.043 (120)	0.227** (130)	0.120 (97)	-0.068 (105)
Hap8	-0.041 (120)	0.237** (130)	0.120 (97)	0.065 (105)
Neu12	0.177 (101)	0.260* (95)	0.315* (93)	0.167 (87)
Ang12	0.132 (101)	0.211* (95)	0.149 (93)	0.146 (87)
Hap12	0.227* (101)	0.218* (95)	0.262* (93)	0.080 (87)
Neu18	-0.086 (84)	0.127 (82)	-0.022 (79)	-0.039 (88)
Ang18	-0.023 (84)	0.131 (82)	-0.062 (79)	0.106 (88)
Hap18	-0.161 (84)	0.03 (82)	-0.059 (79)	-0.050 (88)

Initial inspection of the sample found that too many data points were lost in analyses that included all measures at each timepoint, due to list-wise deletion. Indeed, a full omnibus ANOVA with Age, Face Emotion, and Maternal Stress had only 19 degrees of freedom. As such, analyses were broken down into separate ANOVAs by age. Thus, each age had a 3 (Face Emotion) by 2 (Maternal Stress) interaction. Maternal stress was split into two groups based on a median split at each age.

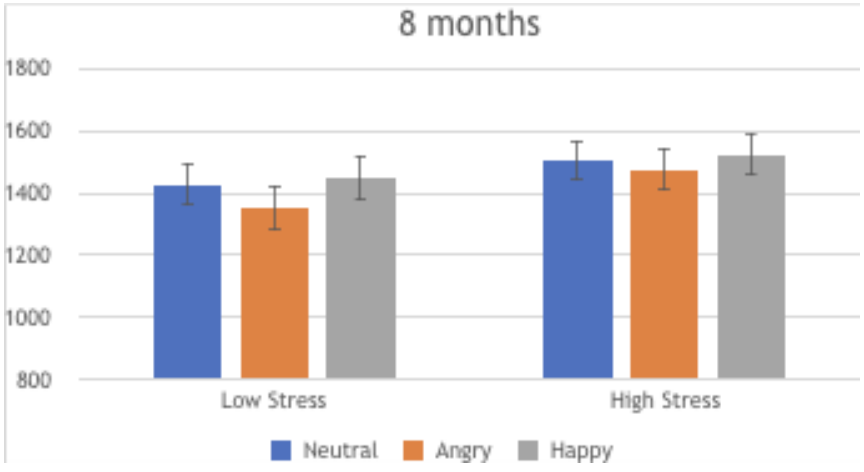
4 months

Neither the main effect of Emotion, $F(2,170) = 1.25$, $p = 0.29$, the main effect of Stress, $F(1,85) = 0.37$, $p = 0.55$, nor the Emotion by Stress interaction, $F(2,170) = 0.86$, $p = 0.42$, were significant.



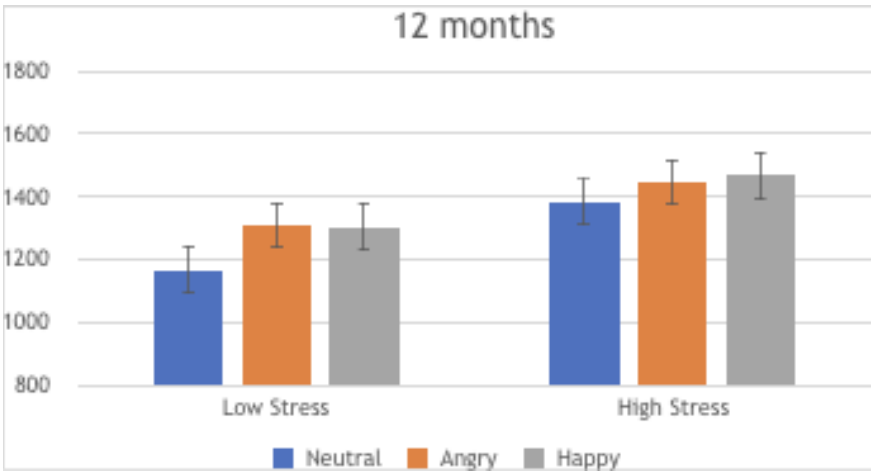
8 months

Neither the main effect of Emotion, $F(2,256) = 1.64$, $p = 0.20$, the main effect of Stress, $F(1,128) = 1.23$, $p = 0.27$, nor the Emotion by Stress interaction, $F(2,256) = 0.22$, $p = 0.80$, were significant.



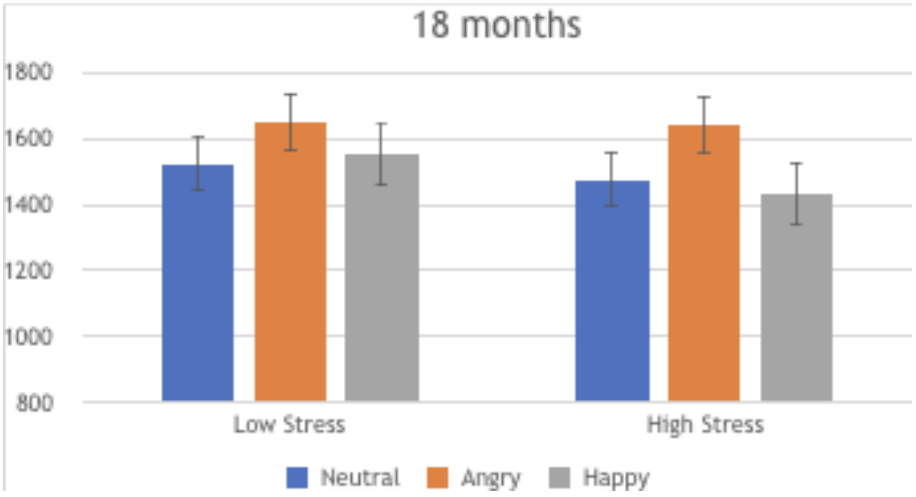
12 months

The main effect of Emotion, $F(2,182) = 3.20$, $p = 0.04$, was significant, indicating that at 12 months the infants took longer to detach from happy emotions, followed by angry and neutral emotions. In addition, the main effect of Stress approached significance, $F(1,91) = 3.61$, $p = 0.06$, due to the slightly longer fixations to all faces in the infants of high stress moms relative to low stress moms. However, the Emotion by Stress interaction, $F(2,182) = 0.34$, $p = 0.71$, was not significant.



18 months

The main effect of Emotion, $F(2,172) = 9.47$, $p < 0.001$, was significant, indicating greater dwell time (more attention to) angry faces across all of the infants. Neither the main effect of Stress, $F(1,86) = 0.23$, $p = 0.63$, nor the Emotion by Stress interaction, $F(2,172) = 0.964$, $p = 0.39$, was significant.



Discussion

The current findings indicate that the emotion by stress interaction was not significant at any of the time points measured. That is, from the age of 4 months to 18 months, differences in infants' dwell time across neutral, angry, and happy emotional faces are not directly associated with the influence of maternal stress. When looking at the variables of emotion and stress individually, findings emerged at different ages. For the variable of emotion, there was no significant main effect at ages 4- and 8- months. However, for the time points of 12- and 18- months, significant differences emerge indicating that as the infants aged, they paid more attention to angry faces compared to neutral and happy faces. The variable of stress did not have significant effects at any of the time periods, when examining across the emotion faces. Specifically looking at the 12-months data, stress was approaching significance, this indicated that there was a slightly longer fixation to all faces in the infants of high stress moms relative to low stress moms. However, Table 2 indicates significant positive zero-order correlations between maternal stress at 8 months and individual dwell times at 8 and 12 months. This suggests that a larger, more robust sample may have been able to detect significant patterns in the ANOVA that lagged from one age to the next.

The study suggests that within the first one and half years of life of infants, attention to emotional faces is not robustly associated with our specific measure of maternal stress. As infants age they tend to pay more attention to angry faces rather than happy and neutral ones. This can be caused by a number of reasons. For example, the simple physical structure of anger on a face might intrigue the infant (Lobue & Deloache, 2011). These findings align with Leppänen et al. (2018), which found that as infants age they dwell longer at angry facial emotions compared to happy. This change can be caused by the simple development of interest in different facial structures. At 8 months, infants did not dwell longer on the emotion of anger unlike the previous literature. Heck et al. (2016) found that by 7 months infants focus more attention on fear emotions rather than happy ones. Our study could have failed to replicate these findings because of the specific characteristics of the infants participating. For example, the infants might not be predisposed to experiencing a threatened environment. Threatening facial expressions can be a sign to potential danger (LoBue, 2009), if these infants are predisposed to high levels of anger, they may not be conditioned to looking at threatening stimuli.

Our findings add to the evidence that as infants develop, they dwell longer toward threatening stimuli--in particular, angry emotional faces. This bias is important because it allows infants to determine if their environment is potentially threatening. At the 12-month time period, the emotion by stress interaction approached significance, which indicates that there is an association between maternal stress and emotional attention that may be evident with a larger sample or more refined measures of stress. For example, prior work has used levels of the hormone cortisol to capture variations in stress levels (Bayazit, 2009).

Our findings also raise questions that require further investigation. First, the study used participants from a similar background with regards to demographics. If the study used a wider participant pool across various states, rather than states from the tri-state area there is potential room for a different outcome. If there was no access to participants across various locations, looking at each town (Harrisburg, State College & Newark) separately there might be an association of maternal stress to infant facial attention. Studies have shown that people from urban areas report more problems and conflict compared to rural areas (Elgar et al., 2003).

Newark is classified as an urban area, so the mothers from this location might have scored higher on the CHAOS and PDHSR leading to a difference in processing of emotions in the infants. Furthermore, the majority of the participants identified as white, if there was more of a divide in the ethnicity the maternal stress might be higher. That said, post-hoc analyses found that stress levels only differed by location at 18 months, with the highest levels at Newark. The study could be extended by not only examining infant and caregiver pairs from different towns but also looking at different ages.

While we did not incorporate maternal ages into the analysis, studies show that adolescent mothers experience more stress than non-adolescent mothers (Coll et al., 1986). Adolescent mothers tend to have less support from their environment which can also add additional stress. Younger mothers tend to be less responsive and use more punishment on their child (Coll et al., 1986).

In this current study we only examined trajectories up to 18 months. Future studies are needed to look at the individuals at an older age. It may be that the pattern of attention bias to angry faces, if maintained at later ages, could show signs of anxiety from maternal stress. Maternal stress during pregnancy is connected to internalizing behaviors (Park et al., 2014). However, internalizing behaviors typically emerge later in childhood (Van Zalk, 2020). Therefore, conducting this research at a later time point in infants could create a stronger association between maternal stress and development of things.

In conclusion, the results of the study indicate that as infants develop, they tend to dwell longer on the emotion of anger compared to neutral and happy emotions. There was no interaction between attention to emotions and maternal stress at 4-, 8-, 12- nor 18- months. However, we noted some indications of direct correlations. As we continue this research, there is a need for a larger participant pool examining across larger trajectories. This could allow for a stronger association between maternal stress and risk behaviors to emerge.

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