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**INFLUENCES OF CHAOTIC HOME ENVIRONMENTS AND MATERNAL
EMOTION DYSREGULATION ON INFANT RESPIRATORY SINUS
ARRHYTHMIA**

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Abstract

Research indicates that infant development is greatly influenced by the home environment, as well as parental emotion regulation. Chaotic home environments have been demonstrated to be a detriment to infant regulatory and behavioral outcomes. Research has also shown that maternal emotion dysregulation affects infant emotional development and respiratory sinus arrhythmia (RSA), a measure of infant regulatory capacity. Although compelling research exists in each of these areas, to my knowledge there are no studies that test for interactions between chaotic home environments and maternal emotion dysregulation on infant RSA. Thus, I aimed to explore how chaotic home environments would affect infant parasympathetic functioning measured via RSA, and how the relation between chaotic home environments and infant RSA would change based on maternal emotional dysregulation. A group (n=104) of mothers completed the Confusion, Hubbub, and Disorder Scale (CHAOS) and Difficulties in Emotional Regulation Scale (DERS) at 7-months post-partum. Respiratory arrhythmia (RSA) was measured for infants during a baseline task. I used hierarchical linear regression analyses to test for the influences of chaotic home environments and maternal emotion

dysregulation on infant baseline RSA. Contrary to hypotheses, CHAOS scores did not predict lower infant baseline RSA. Maternal emotion dysregulation scores also did not affect the relation between CHAOS scores and infant baseline RSA. However, maternal CHAOS and DERS scores were highly related. Future studies should test RSA reactivity, other physiological outcomes such as electrodermal activity, and the directionality of the association between maternal CHAOS and DERS scores.

Influences of Chaotic Home Environments and Maternal Emotion Dysregulation on Infant Respiratory Sinus Arrhythmia

The family a child is raised in is one of the most important influences on that child's development. Parenting and attachment style, home environment, emotional context, abuse, and many other familial factors help to shape a child's development from birth. Though many social factors will influence a person throughout their life, the first of these influences will always be the family (Belksy et al., 1984). Early in infancy, the infant's relationship with their mother is especially important to their development (Cheung et al., 2020). It is essential to view an infant's growth through the lens of their relationship with their mother and that infant's home environment. Even so, our understanding of several important familial influences on infant development is limited. Specifically, household chaos and parental emotion dysregulation are under-researched regarding infant development. Household chaos and emotion dysregulation are important familial factors that could have significant impacts on infants.

Household Chaos

Chaos in the home is one developmental influence that has received limited attention in research until recently. Chaos in the context of the home environment refers to a state of confusion, agitation, noise, crowding, and lack of order or routines, as well as a sense of rush and disorganization (Deater-Deckard et al., 2012; Dumas et al., 2005). An example of a chaotic home environment could be a home in which people are constantly going in and out, the TV is typically on, and bed or mealtimes change dramatically from day to day.

One common point of confusion is that because household chaos is highly related to low socioeconomic status that these two terms can be used interchangeably. Chaos has been demonstrated by numerous studies to be related to low socioeconomic status, but chaos is a valid construct on its own and exists among groups of all income levels (Dumas et al., 2005; Evans et al., 2005; Petrill et al., 2004; Whitesell et al., 2015). Few studies have distinguished chaos from socioeconomic status and therefore do not explain the unique effects household chaos may have on developmental outcomes. This may be due in part to past difficulties conceptualizing and measuring chaos independently from socioeconomic status. Matheny et al. (1995) developed a self-measure report to measure how chaotic an individual's home is, named the Confusion, Hubbub, and Order Scale (CHAOS). It has since been much easier for researchers to study chaos as it relates to child development and other outcomes. Specifically, chaos has been shown to have significant impacts on young children (Evans et al., 2005).

Matheny et al. (1995) found that toddlers in houses with higher noise-confusion have been reported to have more negative moods, be less approachable, and be less adaptive. Home characteristics related to chaos such as ambient noise, crowding, and traffic patterns were also linked to negative outcomes on cognitive performance and school achievement. More recently, chaos in the home has been linked with a large number of emotional and behavioral outcomes for young children. It has been found that chaotic home environments are related to poor behavioral outcomes in children, even when controlling for low socioeconomic status, and that parental discipline is less effective in disorganized households (Evans et al., 2005; Petrill et al., 2004). It was also found in one study that chaos was related to maternal depression, which can have a whole

other set of implications for the family and children's development (Pike et al., 2006). Some of poverty's negative effects on children's emotional development may be due to home chaos being more prevalent among families with lower socioeconomic status (Evans et al., 2005).

In a meta-analysis conducted by Marsha et al. (2020), it was found that chaotic home environments are associated with a wide range of adverse child and family outcomes. Chaos in the home was generally associated with worse cognitive outcomes and poorer executive functioning. Chaos was also found to be associated with poor socio-emotional outcomes and, notably, higher cortisol levels in 7-year-old children who had lower baseline respiratory sinus arrhythmia (RSA). Despite the literature examining the association between chaos and child development, studies investigating associations between household chaos and infant development are almost non-existent. The far-reaching effects of household chaos on children warrant further investigation in samples of infants.

It is still an issue of open discussion why chaotic home environments have these adverse effects on children and families, but there have been various theories proposed to explain the influence of chaos. High amounts of noise and distraction may disrupt parent-child relationships and social interactions or may indirectly affect parenting by causing parents added stress. This additional stress may make it more difficult to provide effective parenting (Whitesell et al., 2015). Angry and hostile parenting patterns are generally more prevalent in stressful circumstances (Deater-Deckard et al., 2012). Chronic chaos could also affect infant development by making it more difficult for infants to rely on consistent routines and parental support due to disorganization in the

home. This household disorganization could influence infants to have disorganized attachment styles, which are problematic for emotional development (Conradt et al., 2013).

Chaos in the home has also been shown to associate with children's biophysiological functioning, which could have implications for young children's abilities to cope effectively with their environments. One study found that chaos in the home was associated with higher baseline cortisol levels in young children, even when controlling for low socioeconomic status (Dumas et al., 2005). Because cortisol is a common biological marker of stress, this finding is indicative of higher levels of chronic stress experienced by children living in chaotic environments. This chronic stress would potentially, over time, tax the parts of the brain that help children respond to stress, such as the sympathetic and parasympathetic nervous systems. The wear and tear on these systems could limit children's ability to respond productively to stress and other emotional demands. Chaos in the home would likely affect infants in a similar manner.

Maternal Emotion Dysregulation

Another very important factor in infancy is the mother's emotional state. Specifically, maternal emotion dysregulation is related to some adverse outcomes in children and infants. Emotion dysregulation is characterized by patterns of emotions that are too intense, subject to change, rigid, prolonged, or that interfere with goal-oriented behavior (Crowell et al., 2020). Emotion dysregulation may characterize emotions that endure even after a person attempts to change those emotions, or emotions that interfere with one's quality of life or lead to ineffective behavior. Emotion dysregulation may also refer to emotions that don't fit the context in which they arise and emotions that interfere

with interpersonal relationships (Cole & Hall S. E., 2008). Emotions themselves are not a bad thing, and, in fact, are necessary for adaptation to our environment. However, emotions can become problematic when they exert too much influence over our behavior and are difficult to regulate (Dollar & Calkins, 2016).

Emotion dysregulation is transdiagnostic, meaning that it is present in a wide variety of psychological disorders. Because it doesn't apply to one specific form of psychopathology, measuring emotion dysregulation can be helpful in the treatment of a variety of emotional and mental disorders (Thompson, 2019). Difficulties with emotion regulation characterize almost all forms of psychopathology (Beauchaine, 2015). Emotion dysregulation, therefore, could be indicative of many different forms of psychological distress, such as depression, anxiety, and post-traumatic stress disorder. Researchers have historically studied specific forms of maternal psychopathology, but the transdiagnostic nature of emotion dysregulation may make it a more effective predictor of maternal and infant outcomes than simply studying maternal depression or anxiety (Gao et al., in press).

Because emotion dysregulation can affect new mothers and their parenting styles, it is compelling to assess how maternal emotion dysregulation affects child outcomes. One case study of four moms with high levels of emotion dysregulation found that dialectical behavior skills training, a variation on a common therapy for emotion dysregulation, significantly improved parenting and child outcomes. It was theorized that the mothers in the sample were able to better manage their household better due to better emotion regulation and emotional coping skills (Martin et al., 2017). Another study by Leerkes et al. (2020) involving 259 mother-infant dyads found that self-reported maternal

emotion dysregulation predicted a higher likelihood of infant attachment disorganization and more behavior problems. A third study by Lotzin et al. (2016) found that higher maternal emotion dysregulation predicted heightened mother-infant gaze synchrony, which is related to maladaptive mother-child interaction and socio-emotional development. Emotion dysregulation during pregnancy may even have negative consequences for a mother and her babies, such as more susceptibility to self-injurious thoughts and behaviors, as well as other mental health concerns (Lin et al., 2019).

Another study by Gao et al. (in press) found maternal emotion dysregulation to be specifically related to infant psychophysiology. It was found in a sample of 7-month-old infants that the mother's difficulties with emotion dysregulation were highly related to respiratory sinus arrhythmia (RSA) reactivity in infants. However, maternal emotion dysregulation was not found to be related to infants' respiratory sinus arrhythmia at baseline. These findings, while somewhat mixed, indicate that maternal emotion dysregulation may have a significant impact on infant development and physiology.

It is not known why mothers' emotion dysregulation affects children and infants in these ways, but numerous theories have been proposed. Firstly, infants demand a great deal of attention and resources, which can make the transition to motherhood very difficult for many women (Martin et al., 2017). Emotion dysregulation may make this transition even more difficult for new mothers. According to Rutherford et al. (2015), maternal emotion dysregulation may affect young children through a tripartite model: 1) Children learn by observing their parents' emotion regulation and response to emotional stimuli. Infants will begin to directly model their parent's behavior from very early in their development, 2) Parent practices greatly impact infant and child development.

Parenting that is reactive, emotionally charged, characterized by outbursts, and overly labile can have very poor effects on children, and 3) Romantic attachment of parents and the attachments of mothers to their children are impacted by emotion dysregulation. These attachments are associated with children's ability to regulate their own emotions.

While we now have a broader understanding of mothers' emotion dysregulation and its potential effects on child development, studies examining the links between maternal emotion dysregulation and infant development are very limited. In light of previous research, the relation between maternal emotion dysregulation and infant outcomes must be more thoroughly researched.

Infant Respiratory Sinus Arrhythmia (RSA)

Because infants are nonverbal for roughly the first year of life, the only ways to measure infant development are through observation and physiological measures. Observational methods can often be subjective to parents' emotional states, so physiological data offer a promising and valid method of studying infant development. One widely used measure is respiratory sinus arrhythmia (RSA). RSA refers to the change in heart rate from when one inhales to when one exhales. Generally, the heart rate will decrease slightly when exhaling (Garber & Dodge, 1991). The increases and decreases in heart rate across the respiratory cycle are controlled by the vagus nerve. The vagus nerve is controlled by the parasympathetic branch of the nervous system, which is responsible for bringing the body back to homeostasis after a stressful event. The parasympathetic branch of the nervous system is antagonistic to the sympathetic branch, with the sympathetic nervous system generally being involved in initiating the body's fight or flight response (Cole & Hall S. E., 2008). In essence, the sympathetic nervous

system prepares the body to respond to a stimulus, and the parasympathetic nervous system restores the body to a resting state. Generally speaking, when external stressors or demands are present, the body allocates resources to the sympathetic nervous system and reduces parasympathetic input, reducing RSA and causing the heart to beat with less variability across the respiratory cycle. In this way, RSA is an indirect measure of the parasympathetic nervous system (Tonhajzerova et al., 2016).

RSA, by measuring parasympathetic functioning, can be used to assess the brain's capacity to process emotional stimuli and regulate emotional responses (Beauchaine, 2015). RSA is generally measured in two ways. The first is at baseline, in which RSA is measured when a person is at rest. The second is RSA reactivity, which is the difference between RSA from when a person is at rest to their RSA when exposed to a stressor. When a person is at rest, higher baseline RSA is generally indicative of increased ability to respond to stressors and maintain homeostasis, while a lower baseline RSA could be indicative of chronic taxation of the parasympathetic nervous system (Butler et al., 2006). RSA can also be representative of top-down control of emotional states by the prefrontal cortex, or in other words more cognitive control over one's emotions (DeGangi et al., 1991). It has also typically been thought that high baseline RSA, or RSA at rest, is characteristic of a person being adaptive to emotional stimuli, promoting better emotion regulation, and making people less susceptible to psychopathology (Beauchaine, 2015; Butler et al., 2006; Gentzler et al., 2009; Rottenberg et al., 2002). One explanation for the relation between high RSA and emotion regulation is that high baseline RSA makes possible a greater decrease in RSA in response to emotional stimuli, potentially indicating more capacity for emotional adaptation (Gentzler et al., 2009).

In infants, however, baseline RSA may be predictive of different outcomes. In a study by Conradt et al., (2016) it was found that high baseline RSA was predictive of better behavioral outcomes at age 3 when infants experienced low levels of caregiving stress, but predictive of high levels of behavioral dysregulation when infants experienced high levels of caregiving stress. These results show that high RSA may simply be a measure of adaptability to the environment, which can be very healthy for infants in positive family environments but very detrimental for infants in poor family environments. It was found in the same study that low baseline RSA predicted worse behavioral outcomes than those of infants with higher RSA levels regardless of other factors. Though there is still much debate about the developmental effects of baseline RSA, it would seem that, in general, high RSA is predictive of positive outcomes for infants. This is especially true if the home environment can be improved by parenting interventions and positive maternal affect.

It has been widely demonstrated in prior literature that home environments shape physiological responses to stress (Conradt et al., 2013; Flinn & England, 1995; Gao et al., in press; Leerkes & Sommers, 2020). There is also some evidence that chaos in the home is associated with changes in infant stress-functioning and physiological arousal. According to previous research, chaos in the home is predictive of higher cortisol levels, which is related to increased sympathetic activity and the reduction of vagal control over the heart, which would theoretically result in lower baseline RSA (Dumas et al., 2005). There is a great possibility that chaos in the home and maternal emotion dysregulation could affect infant baseline RSA. Maternal emotion dysregulation is associated with infant RSA reactivity (Gao et al., in press). Though maternal emotion dysregulation was

not found to be associated with infant baseline RSA in previous studies, it is still plausible that maternal emotion dysregulation may influence the association between chaos in the home and infant baseline RSA.

Present Study

The present study was part of a longitudinal study of mothers and their infants in the Mountain West. I aimed to examine the associations between chaotic home environments, maternal emotion dysregulation, and infant baseline RSA at 7 months old. This study expanded upon previous research by evaluating a specific physiological outcome, namely baseline RSA. In line with previous research, I hypothesized that:

- a) Higher levels of chaos would be associated with lower baseline RSA in 7-month-old infants.
- b) Maternal emotion dysregulation would be associated with lower baseline RSA in 7-month-old infants.
- c) There would be a stronger relation between chaos and infant baseline RSA among mothers experiencing high emotion dysregulation, and a weaker relation between chaos and infant baseline RSA among mothers experiencing low emotion dysregulation.

METHOD

Participants

The mothers and infants in this study were involved in a longitudinal study spanning the third trimester of pregnancy to 36-months postpartum. My research involves measures taken only at 7-months postpartum. Women were recruited from prenatal care centers affiliated with the University of Utah via flyers, brochures, and social media

posts. All women interested in the study took a survey to answer questions about eligibility. To be eligible for the study, the women needed to be between 18 and 40 years of age and be less than 25-weeks pregnant at the time of recruitment. Participants also had to have no pregnancy complications, no substance abuse during pregnancy, have an anticipated singleton delivery, and planned delivery at a participating hospital. Women also completed the Difficulties in Emotion Regulation Scale (DERS, Gratz & Romer, 2004) at the time of recruitment. Women with high or low DERS scores were oversampled to achieve an even distribution of emotion dysregulation in the sample.

One hundred and sixty-two pregnant women were initially recruited for the study. One-hundred and thirty-five women participated in the portion of the study 7-months after birth. Twenty-one of the women only filled out surveys and did not attend the lab visit. Two women only attended the lab visit but did not complete the questionnaires. Thus, all data was present for 112 of the mothers. There were multiple reasons for participants not participating in the 7-month portion of the study. Several of the participants were unable to be contacted or were too busy to participate, one participant moved, and one baby passed away before the 7-month portion of the study. The only apparent systematic difference between participants that participated at 7-months and those who did not was that the mothers participating at 7-months had a slightly higher average income than the prenatal sample. Of the 112 mother-infant dyads, physiological data was usable for 104 of the infants. One infant's data was missing due to equipment failure, four infants' data was missing due to participant distress during the task, and three were missing due to miscellaneous reasons. Therefore, in the final analyses, 104 mother-infant dyads remained.

Nearly half of the sample was White/Caucasian (48.8), and most of the women were very well-educated (85.8 percent had completed at least some college). That being said, there was a wide range of ethnic, racial, and socioeconomic backgrounds among participants. Demographic information can be found in Table 1. Participants received up to \$75 in compensation for 7-month participation. All study procedures were approved by the Institutional Review Board at the University of Utah.

Table 1

Demographic Characteristics of Participants at 7-months Postpartum

Characteristic	<i>n</i> (%)	Mean (<i>SD</i>)	Range
<i>Maternal Demographics</i>			
Age		29.21 (<i>SD</i> = 4.75)	19-41
Race and Ethnicity			
American Indian or Alaskan Native, not Hispanic/Latina	3 (1.9)		
American Indian or Alaskan Native, Hispanic/Latina	1 (.6)		
Asian, not Hispanic/Latina	13 (8.0)		
Hawaiian or Pacific Islander, not Hispanic/Latina	1 (.6)		
Black/African American, not Hispanic/Latina	2 (1.2)		
Black/African American, Hispanic/Latina	63 (38.9)		
White/Caucasian, not Hispanic/Latina	16 (9.9)		
White/Caucasian, Hispanic/Latina	10 (6.2)		
Multiracial, not Hispanic/Latina	23 (18.6)		
Multiracial, Hispanic/Latina	4 (2.5)		
Multiracial, Hispanic/Latina	19 (11.7)		
Highest Level of Education			
Less than 12 th grade	41 (25.3)		

High school or equivalent	39 (24.1)		
Junior college/technical school	27 (16.7)		
College graduate	6 (3.7)		
Any post graduate school	7 (4.3)		
Household Income Level	6 (3.7)		
Under \$9,000	9 (5.6)		
\$9,000-\$14,999	5 (3.1)		
\$15,000-\$19,999	13 (8.0)		
\$20,000-\$24,999	13 (8.0)		
\$25,000-\$29,999	35 (21.6)		
\$30,000-\$39,999	16 (9.9)		
\$40,000-\$49,999	14 (8.6)		
\$50,000-\$79,999	6 (3.7)		
\$80,000-\$99,999			
\$100,000 or more			
Refuse to answer			
<i>Infant Demographics</i>			
Age (in days)		201 (<i>SD</i> = 28.32)	146-305
Sex			
Male	53 (39.8)		
Female	55 (41.4)		
No response	25 (18.8)		
Race			
American Indian or Alaskan Native	1 (.6)		
Asian	5 (3.1)		
Hawaiian or Pacific Islander	1 (.6)		
Black/African American	2 (1.2)		
White/Caucasian	88 (54.3)		
Other	5 (3.1)		
More than 1 race	23 (14.2)		

Procedure

Mothers and infants came in for scheduled lab meetings at approximately 7-months postpartum. The mothers filled out several computer surveys about themselves, their infants, and their home environment. The mothers and infants then completed a

variety of tasks while their heart rate was measured with electrocardiography. The baseline task consisted of the baby watching a Baby Einstein video for 2-minutes while sitting in their mother's lap (Conradt et al., 2013). The study would stop if the baby or mother became too distressed to continue, such as if the baby was crying and unable to be soothed.

Measures

Chaos in the Home

Matheny et al. (1995) developed a self-measure report to measure how chaotic an individual's home is. This measure is called the Confusion, Hubbub, and Order Scale (CHAOS). Items are rated on a Likert-type scale from 1-5 (1 being "definitely untrue" and 5 being "definitely true"). Examples of items include: my child has a regular bedtime routine, you can't hear yourself think in our home, it's a real zoo in our home, etc.

Matheny et al. also ran a study to make sure the self-reported CHAOS scale was a valid measure of observable chaos in the home. The CHAOS scale was compared to observable measures of chaos, such as noise level and home traffic patterns. These researchers found that the CHAOS scale is a very accurate measure of the observable atmosphere in the home and has high ecological validity (Matheny et al., 1995). The scale has a Cronbach's α of 0.79 and test-retest reliability (12-month interval) of $r = 0.74$.

The version of the CHAOS scale used in this study was a 6-item short version. The creation of this short version is unclear but has been used in studies by Pike et al. (2006) and Petrill et al. (2004). It appears that the 6-items used in this short version are those that most closely correlated with physical observance of chaos in the home from the

Matheny study (1995). A single score was computed by summing the responses for all 6 items, with questions 1, 4, and 6 being reverse scored ($M = 12.86$, $SD = 3.83$).

Emotion Dysregulation

Emotion dysregulation was measured using the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). This is a 36-item self-report addressing emotion regulation. Each item was rated by the participant on a scale of 1-5 (1 being “almost never” and 5 being “almost always”). Some examples of items include: when I’m upset I lose control over my behaviors, I experience emotions as overwhelming and out of control, etc. Items in the scale are summed for a composite score, with some of the items being reverse scored ($M = 71.3$, $SD = 23.32$). The DERS has test-retest reliability of $ICC = .88$ and strong internal consistency (Cronbach’s $\alpha = .93$; Gratz & Roemer, 2004).

Numerous studies have tested the validity of the DERS self-report. Ritschel et al. (2015) found that DERS was consistent for men and women, and consistent in various racial groups. In a longitudinal study involving adolescents, Vasilev et al. (2009) found that DERS scores were associated with respiratory sinus arrhythmia (RSA) scores (considered to be a strong physiological measure of emotion dysregulation). Other studies have found the DERS to be internally consistent and associated with psychopathology (Neumann et al., 2010; Bardeen et al., 2012; Dan-Glauser & Scherer 2013).

Respiratory Sinus Arrhythmia

Infants’ baseline respiratory sinus arrhythmia (RSA) was measured by attaching two electrodes to the infant’s right clavicle and left ribcage using MindWare mobile devices (MindWare Technologies Ltd., Gahanna, OH; Biolab software version 3.1). RSA

is the high-frequency band of the waveform (0.24 – 1.04 Hz for infants). This data was scored in 30-second epochs by trained research assistants. The MindWare software automatically computed RSA for each 30-second epoch. The software flagged R peaks within each QRS complex and identified whether inter-beat intervals are within the expected variability in comparison to the surrounding data. Research assistants then went through each epoch to review flagged R peaks and make corrections when needed, such as a misidentified R-peak. Epochs were considered missing if there were less than 30 seconds of useable data or if RSA values fell outside of the expected range for infants. Baseline RSA values were computed by averaging the scores of the 4 epochs obtained during the 2-minute video baseline (range: 0.92-6.25).

Analytic Plan

Preliminary Analyses All analyses were run in RStudio Version 1.4.1717. Descriptive analyses were run for demographic information and maternal DERS scores, CHAOS scores, and infant baseline RSA. Correlation analyses were also run among the variables of interest. Missing data were handled as deemed appropriate (e.g., listwise deletion, full information maximum likelihood [FIML], etc.). All continuous independent variables were grand-mean centered in order to alleviate multicollinearity. Grand-mean-centered DERS and CHAOS scores were multiplied by each other in order to create an interaction term. Infant baseline RSA values were inspected to ensure that assumptions of normality were met and that there were no outliers.

Primary Analyses I ran hierarchical linear regression models in which various predictors were regressed onto infant baseline RSA. The first model included only planned covariates, including maternal income level and infant sex. I added CHAOS and

DERS scores as separate predictors of infant baseline RSA in the second model. Finally, the third model included the interaction term between CHAOS and DERS scores. Thus, analyses showed if any covariates played a role in the effects noticed, whether CHAOS and DERS scores independently predicted infant baseline RSA and if CHAOS and DERS interacted to predict infant baseline RSA.

RESULTS

Preliminary Analyses

Table 2 outlines the descriptive statistics and correlation analyses among variables of interest. Contrary to predictions, there was no significant correlation between maternal emotion dysregulation and infant baseline RSA, nor between maternal self-reported CHAOS scores and infant baseline RSA. There was, however, a strong, statistically significant correlation between maternal DERS scores and maternal CHAOS scores. The correlation between DERS and CHAOS scores was not hypothesized does not tell us the directionality of the association, simply that the two variables are related. The scatterplot of the association between DERS and CHAOS scores is shown in Figure 1.

Table 2

Descriptive Statistics and Correlation Analyses Among Primary Variables of Interest.

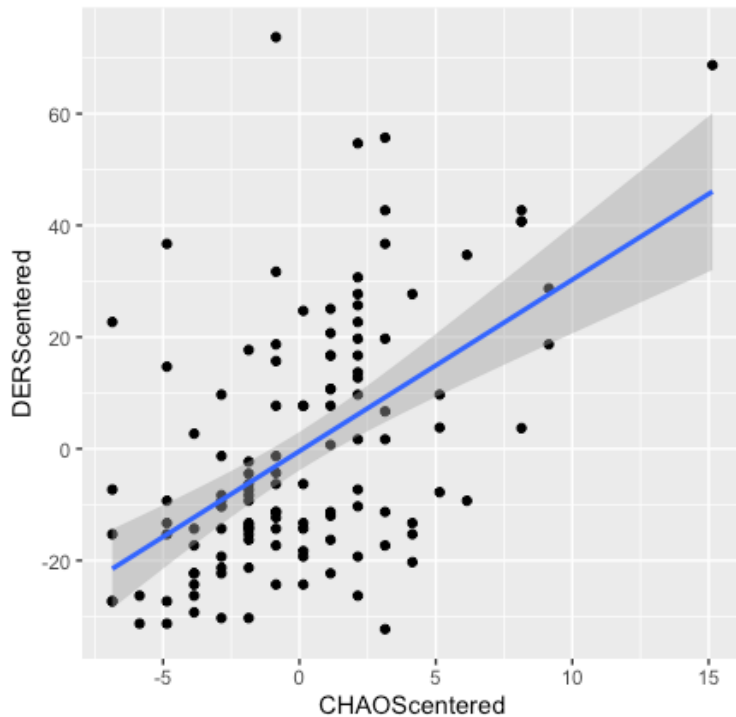
Variable	<i>M (SD)</i>	1	2	3
1. DERS	71.3 (23.32)	—	0.523*	0.020
2. CHAOS	12.86 (3.83)	0.523*	—	0.121
3. Infant RSA	3.54 (0.93)	0.020	0.121	—

Note. DERS = Difficulties in Emotion Regulation Scale; CHAOS = Confusion,

Hubbub, and Order Scale; Infant RSA refers to infant baseline RSA; * $p < .001$.

Figure 1

Correlation Between Centered CHAOS and Centered DERS Scores



Primary Analyses

I ran a series of linear regression models to test for predictive associations among maternal emotion dysregulation, chaos in the home, and infant baseline RSA. The first model included only the covariates of interest, including household income and infant sex. Results of this model indicated that household income and infant sex did not predict infant baseline RSA, $t(80) = .51, p = .61$ and $t(80) = -.23, p = .82$, respectively. The second model included maternal emotion dysregulation and chaos in the home as main effects. Results indicated that maternal emotion dysregulation nor chaos in the home predicted infant baseline RSA, $t(78) = .04, p = .97$ and $t(78) = .55, p = .59$ respectively. Finally, the third model included the interaction effect between maternal emotion dysregulation and chaos in the home. Results for this final model indicated that the interaction between maternal emotion dysregulation and chaos in the home on infant baseline RSA was nonsignificant, $t(77) = -1.34, p = .19$. In sum, the results did not align

with my hypotheses that chaotic home environments would predict infant baseline RSA, that maternal emotion dysregulation would predict infant baseline RSA, nor that there was an interaction effect between emotion dysregulation and chaos.

DISCUSSION

The aim of this study was to examine how chaotic home environments and mothers' difficulties with emotion regulation affect infant parasympathetic functioning. Chaos in the home and maternal emotion dysregulation have been demonstrated to have various effects on child development, but research into effects on infants is rare (Evans et al., 2005; Gao et al., in press; Petrill et al., 2004). Thus, this is the first study to my knowledge examining the relation between household chaos and infant parasympathetic functioning as measured by respiratory sinus arrhythmia (RSA).

The first hypothesis was that higher levels of chaos would be related to lower baseline RSA in 7-month-old infants. This hypothesis was not supported by the data. There was no association between self-reported household chaos and infant baseline RSA in our study. The second hypothesis, that maternal emotion dysregulation would be associated with lower levels of infant baseline RSA, was also unsupported. The third hypothesis was that there would be a stronger association between chaos and infant baseline RSA among mothers experiencing high emotion dysregulation, and that among mothers experiencing low emotion dysregulation the association between chaos and infant baseline RSA would be weaker. This hypothesis was also unsupported by the data. Mothers' self-reported emotion dysregulation did not affect the relation between chaos in the home and infant baseline RSA.

One explanation for the lack of association between chaos, maternal emotion dysregulation, and infant baseline RSA may be the stability of baseline RSA in infants over the first year of life. A study by Porter et al. (1995) found that each infant in their sample maintained a relatively stable baseline RSA from 1 month to 6 months of life. Their results demonstrated that an individual infant's baseline RSA at 1 month of age was fairly similar to that same infant's baseline RSA at 6 months of age. Another study by Izard et al. (1991) found similar results regarding the stability of infant baseline RSA. These findings suggest that infant baseline RSA doesn't change much over the first year of life. In the present study, chaos in the home and maternal emotion dysregulation were both measured at 7-months postpartum. This may be problematic since an infant's RSA could have been influenced by household chaos at the time of their birth rather than household chaos measured at 7-months postpartum. An infant's physiology is even influenced by their environment starting in the uterus (Ostlund et al., 2019), and because their RSA may stabilize rather quickly after the first month of life, perhaps a better predictor of a 7-month-old's baseline RSA would be self-reported chaos scores measured prenatally or right after birth. RSA reactivity is much less stable than baseline RSA in young children, so perhaps a measure of RSA reactivity in response to a stressor would be more sensitive to chaotic home environments or maternal emotion dysregulation at 7-months postpartum (Doussard-Roosevelt et al., 2003).

In a recent study by Gao et al. (in press), maternal emotion dysregulation was found to be associated with infant RSA reactivity at 7-months postpartum but not infant baseline RSA at 7-months. Because of my findings that household chaos and maternal emotion dysregulation are so highly related, it would make sense that household chaos

may also influence RSA reactivity in 7-month-olds rather than baseline RSA. Future studies examining the links between household chaos, maternal emotion dysregulation, and infant RSA reactivity would be very insightful.

Baseline RSA also does not tell the entire story of an infant's nervous system functioning or stress reactivity. Baseline RSA is purely a measure of parasympathetic functioning (Butler et al., 2006). Studies have shown RSA to be correlated with electrodermal activity (EDA), a measure of sympathetic functioning, but the association between RSA and EDA is quite variable from child to child and is not linear (Gatzke-Kopp & Ram, 2018). In the present study, we only looked at baseline RSA in infants and did not analyze infant baseline EDA. There is a chance that while household chaos and maternal emotion dysregulation did not associate with infant baseline RSA, they may affect infant sympathetic functioning as measured by EDA. Another measure of the infant stress response is the hypothalamic-pituitary axis (HPA-axis), which is generally measured with salivary cortisol. One study found that baseline RSA did not correlate with cortisol measures in children, but that RSA reactivity did (Doussard-Roosevelt et al., 2003). Thus, it is not possible to say from our study whether chaotic home environments affect infant stress reactivity or nervous system functioning as a whole since multiple pieces are missing from the puzzle. At best, we can say that there is no association between household chaos, maternal emotion dysregulation, and infant parasympathetic functioning at rest.

While my findings did not support my hypotheses, they do not dispute previous literature. Previous literature has demonstrated that chaos in the home impacts children's emotional, cognitive, and social outcomes (Matheny et al., 1995; Evans et al., 2005;

Petrill et al., 2004). There has also been an association demonstrated between chaos and cortisol levels in young children (Dumas et al., 2005). Maternal emotion dysregulation has been linked to higher attachment disorganization and behavioral problems in young children, as well as heightened maternal-infant gaze synchrony, which is maladaptive (Leerkes et al., 2020; Lotzin et al., 2016). As stated previously, the findings from this study only measure parasympathetic activity, so developmental outcomes related to household chaos and maternal emotion dysregulation in previous studies may have other underlying physiological causes. Because of the correlations between parasympathetic, sympathetic, and HPA-axis reactivity, I assumed in the present study that infant baseline RSA would be affected by household chaos and maternal emotion dysregulation, just as previous developmental outcomes have been linked to chaos and dysregulation. This, however, was not the case. The present study did support the findings by Gao et al. (in press) that maternal emotion dysregulation measured is unrelated to infant baseline RSA at 7-months postpartum.

One interesting finding from the present study was that household chaos and maternal emotion dysregulation were highly associated. To my knowledge, no other studies have tested the association between household chaos and maternal emotion dysregulation. Given that all of the information from the present study was collected at one time, it is not possible to determine a causal relation between household chaos and maternal emotion dysregulation. Whereas the disorganization and confusion of chaotic households may contribute to a new mother's difficulty in regulating her emotions, it is also possible that mothers' difficulties in regulating their emotions may influence their perceptions of their household as being chaotic. It is also possible that mothers'

difficulties with emotion regulation may influence their organization and coping skills, contributing to their home feeling more chaotic. Or it is simply possible that there is an unknown factor that accounts for higher DERS and CHAOS scores. Future studies should explore these relations further and test for additional contributing factors in order to inform effective interventions for new mothers and their families.

Limitations and Future Directions

Because of the cross-sectional design of this study, there is no way to test the directionality of the association between household chaos and maternal emotion dysregulation. Future studies should use longitudinal designs to clarify not only how household chaos and maternal emotion dysregulation relate to each other, but also how they may associate with infant RSA over time. Identifying potentially causal relationships between household chaos and emotion dysregulation could inform more effective interventions for new mothers. An additional methodological limitation was that household chaos and maternal emotion dysregulation both were measured via self-report. Although the DERS and CHAOS scales have demonstrated high reliability and ecological validity, future studies should use other measures to interpret these constructs. The use of other measures would help to avoid common method bias, which occurs when all data is collected using the same method, potentially resulting in artificial associations between variables (Jordan & Troth, 2019). One potential measure that could be used in addition to DERS is maternal RSA, which is highly correlated with emotion regulation.

One strength of this study is its large sample size, as well as the diversity in income and ethnicity among participants. The present study is, therefore, more generalizable to a general population. Another strength is the ecological and internal

validity of the self-report scales used, demonstrating that these were valid measures of household chaos and emotion dysregulation. A third strength is the rigor used in measuring RSA using the most accurate power frequencies available for infants and by having trained assistants go through and meticulously correct any errors in the software.

Conclusion

In conclusion, chaotic home environments were not found to influence infant respiratory sinus arrhythmia at rest. Maternal emotion dysregulation did not influence the relation between chaos and infant baseline RSA. There is, however, an association between self-reported household chaos and self-reported maternal emotion dysregulation that warrants further investigation. Determining the causality of the association between household chaos and maternal emotion dysregulation is important in informing future effective interventions for new mothers and their babies.

REFERENCES

- Bardeen, J. R., Fergus, T. A., & Orcutt, H. K. (2012). An examination of the latent structure of the Difficulties in Emotion Regulation Scale. *Journal of Psychopathology and Behavioral Assessment, 34*(3), 382–392. <https://doi.org/10.1007/s10862-012-9280-y>
- Beauchaine, T. P. (2015). Respiratory sinus arrhythmia: A transdiagnostic biomarker of emotion dysregulation and psychopathology. *Current Opinion in Psychology, 3*, 43–47. <https://doi.org/10.1016/j.copsyc.2015.01.017>
- Butler, E. A., Wilhelm, F. H., & Gross, J. J. (2006). Respiratory sinus arrhythmia, emotion, and emotion regulation during social interaction. *Psychophysiology, 43*(6), 612–622. <https://doi.org/10.1111/j.1469-8986.2006.00467.x>
- Cheung, R. Y. M., Chan, L. Y., & Chung, K. K. H. (2020). Emotion dysregulation between mothers, fathers, and adolescents: Implications for adolescents' internalizing problems. *Journal of Adolescence, 83*, 62–71. <https://doi.org/10.1016/j.adolescence.2020.07.001>
- Cole, P., & Hall S. E. (2008). *Child and Adolescent Psychopathology*. John Wiley & Sons, Inc.
- Conradt, E., Beauchaine, T., Abar, B., Lagasse, L., Shankaran, S., Bada, H., Bauer, C., Whitaker, T., Hammond, J., & Lester, B. (2016). Early caregiving stress exposure moderates the relation between respiratory sinus arrhythmia reactivity at 1 month and biobehavioral outcomes at age 3. *Psychophysiology, 53*(1), 83–96. <https://doi.org/10.1111/psyp.12569>
- Conradt, E., Measelle, J., & Ablow, J. C. (2013). Poverty, problem behavior, and promise: differential susceptibility among infants reared in poverty. *Psychological Science, 24*(3), 235–242. <https://doi.org/10.1177/0956797612457381>

- Crowell, S. E., Vlisides-Henry, R. D., Kaliush, P. K. (2020). Emotion generation, regulation, and dysregulation as multilevel transdiagnostic constructs. In S. E. Crowell & T. Beauchaine, (Eds.). *The oxford handbook of emotion dysregulation*. Oxford, England: Oxford University Press.
- Dan-Glauser, E. S., & Scherer, K. R. (2013). The difficulties in emotion regulation scale (DERS). *Swiss Journal of Psychology*, 72(1), 5–11. <https://doi.org/10.1024/1421-0185/a000093>
- Deater-Deckard, K., Wang, Z., Chen, N., & Bell, M. A. (2012). Maternal executive function, harsh parenting, and child conduct problems. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 53(10), 1084–1091. <https://doi.org/10.1111/j.1469-7610.2012.02582.x>
- DeGangi, G. A., DiPietro, J. A., Greenspan, S. I., & Porges, S. W. (1991). Psychophysiological Characteristics of the Regulatory Disordered Infant. *Infant Behavior and Development*, 14, 37–50. [https://doi.org/https://doi.org/10.1016/0163-6383\(91\)90053-U](https://doi.org/https://doi.org/10.1016/0163-6383(91)90053-U)
- Dollar, J. M., & Calkins, S. D. (2016). Emotion regulation and its development. In *The Curated Reference Collection in Neuroscience and Biobehavioral Psychology* (pp. 431–441). Elsevier Science Ltd. <https://doi.org/10.1016/B978-0-12-809324-5.23665-1>
- Dumas, J. E., Nissley, J., Nordstrom, A., Smith, E. P., Prinz, R. J., & Levine, D. W. (2005). Home chaos: Sociodemographic, parenting, interactional, and child correlates. *Journal of Clinical Child and Adolescent Psychology*, 34(1), 93–104. https://doi.org/10.1207/s15374424jccp3401_9

- Evans, G. W., Gonnella, C., Marcynyszyn, L. A., Gentile, L., & Salpekar, N. (2005). The Role of Chaos in Poverty and Children's Socioemotional Adjustment. *Psychological Science, 16*(7), 560–565.
- Flinn, M. V. & England, B. G. (1995). Childhood stress and family environment. *Current Anthropology, 36*(5).
- Gatze-Kopp, L. & Ram, N. (2018). Developmental dynamics of autonomic function in childhood. *Psychophysiology, 55*(11).
- Garber, Judy., & Dodge, K. A. (1991). *The Development of emotion regulation and dysregulation*. Cambridge University Press.
- Gentzler, A. L., Santucci, A. K., Kovacs, M., & Fox, N. A. (2009). Respiratory sinus arrhythmia reactivity predicts emotion regulation and depressive symptoms in at-risk and control children. *Biological Psychology, 82*(2), 156–163.
<https://doi.org/10.1016/j.biopsycho.2009.07.002>
- Gratz, K. L., & Roemer, L. (2004). Multidimensional assessment of emotion regulation and dysregulation: development, factor structure, and initial validation of the difficulties in emotion regulation scale 1. *Journal of Psychopathology and Behavioral Assessment, 26*(1)
- Izard, C., Porges, S. W., Simons, R. F., Haynes, M., Hyde, C., Parisi, M., Cohen, B. (1991). Infant cardiac activity: developmental changes and relations with attachment. *Developmental Psychology, 27*(3), 432-439.
- Jordan, P. J. & Troth, A. C. (2019). Common method bias in applied settings: the dilemma of researching in organizations. *Australian Journal of Management, 45*(1).
<https://doi.org/10.1177/0312896219871976>.

- Leerkes, E., Su, J., Sommers, S. (2020). Mothers' self-reported emotion dysregulation: a potentially valid method in the field of infant mental health. *Infant Mental Health Journal, 41*(5), 642-650.
- Lin, B., Kaliush, P. R., Conradt, E., Terrell, S., Neff, D., Allen, A. K., Smid, M. C., Monk, C., & Crowell, S. E. (2019). Intergenerational transmission of emotion dysregulation: Part I. Psychopathology, self-injury, and parasympathetic responsivity among pregnant women. *Development and Psychopathology, 31*(3), 817–831.
<https://doi.org/10.1017/S0954579419000336>
- Lotzin, A., Romer, G., Schiborr, J., Noga, B., Schulte-Markwort, M., Ramsauer, B. (2015). Gaze synchrony between mothers with mood disorders and their infants: maternal emotion dysregulation matters. *PLoS ONE, 10*(12),
<https://doi.org/10.1371/journal.pone.0144417>
- Marsha, S., Dobson, R., Maddison, R. (2020). The relationship between household chaos and child, parent, and family outcomes: A systematic scoping review. *BMC Public Health, 20*(1).
- Martin, C. G., Roos, L. E., Zalewski, M., & Cummins, N. (2017). A dialectical behavior therapy skills group case study on mothers with severe emotion dysregulation. *Cognitive and Behavioral Practice, 24*, 405–415. www.elsevier.com/locate/cabp
- Matheny, A. P., Wachs, T. D., Ludwig, J. L., & Phillips, K. (1995). Bringing order out of chaos: psychometric characteristics of the confusion, hubbub, and order scale. *Journal of Applied Developmental Psychology, 16*, 429–444.

Moore, G. A. (2010). Parent conflict predicts infants' vagal regulation in social interaction. *Development and Psychopathology*, 22(1), 23–33.

<https://doi.org/10.1017/S095457940999023X>

Neumann, A., van Lier, P. A. C., Gratz, K. L., & Koot, H. M. (2010). Multidimensional assessment of emotion regulation difficulties in adolescents using the difficulties in emotion regulation scale. *Assessment*, 17(1), 138–149.

<https://doi.org/10.1177/1073191109349579>

Petrill, S. A., Pike, A., Price, T., & Plomin, R. (2004). Chaos in the home and socioeconomic status are associated with cognitive development in early childhood: Environmental mediators identified in a genetic design. *Intelligence*, 32(5), 445–460.

<https://doi.org/10.1016/j.intell.2004.06.010>

Pike, A., Iervolino, A. C., Eley, T. C., Price, T. S., & Plomin, R. (2006). Environmental risk and young children's cognitive and behavioral development. *International Journal of Behavioral Development*, 30(1), 55–66. <https://doi.org/10.1177/0165025406062124>

Porter, C. L., Bryan, Y. E., & Hsu, H.C. (1995). Physiological markers in early infancy: stability of 1- to 6-month vagal tone. *Infant Behavior and Development*, 18, 363-367.

Ritschel, L. A., Tone, E. B., Schoemann, A. M., & Lim, N. E. (2015). Psychometric properties of the difficulties in emotion regulation scale across demographic groups. *Psychological Assessment*, 27(3), 944–954.

Doussard-Roosevelt, J. A., Montgomery, L. A., Porges, S. W. (2003). Short-term stability of physiological measures in kindergarten children: respiratory sinus arrhythmia, heart period, and cortisol. *Developmental Psychobiology*, 43(3), 230-242.

- Rottenberg, J., Wilhelm, F. H., Gross, J. J., & Gotlib, I. H. (2002). Respiratory sinus arrhythmia as a predictor of outcome in major depressive disorder. *Journal of Affective Disorders, 71*, 265–272. www.elsevier.com/locate/jadPreliminarycommunication
- Rutherford, H. J. V., Wallace, N. S., Laurent, H. K., & Mayes, L. C. (2015). Emotion regulation in parenthood. *Developmental Review, 36*, 1–14.
<https://doi.org/10.1016/j.dr.2014.12.008>
- Thompson, R. A. (2019). Emotion dysregulation: A theme in search of definition. *Development and Psychopathology, 31*(3), 805–815.
<https://doi.org/10.1017/S0954579419000282>
- Tonhajzerova, I., Mestanik, M., Mestanikova, A., & Jurko, A. (2016). Respiratory sinus arrhythmia as a non-invasive index of ‘brain-heart’ interaction in stress. *Indian Journal of Medical Research, 144*(December), 815–822.
https://doi.org/10.4103/ijmr.IJMR_1447_14
- Vasilev, C. A., Crowell, S. E., Beauchaine, T. P., Mead, H. K., & Gatzke-Kopp, L. M. (2009). Correspondence between physiological and self-report measures of emotion dysregulation: A longitudinal investigation of youth with and without psychopathology. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 50*(11), 1357–1364.
<https://doi.org/10.1111/j.1469-7610.2009.02172.x>
- Whitesell, C. J., Teti, D. M., Crosby, B., & Kim, B. R. (2015). Household chaos, sociodemographic risk, co-parenting, and parent-infant relations during infants’ first year. *Journal of Family Psychology, 29*(2), 211–220.
<https://doi.org/10.1037/fam0000063>

