Daily Parenting Stress and Mood Reactivity:

The Role of Sleep Quality

Chelsea da Estrela

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By: Chelsea da Estrela

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Signed by the final Examining Committee:

_____
Dr. Andrew Chapman, Chair

_____
Dr. Erin Barker, Examiner

_____
Dr. William Bukowski, Examiner

_____
Dr. Jean-Philippe Gouin, Supervisor

Approved by:

_____
Chair of Department or Graduate Program Director

_____
Dean of Faculty

_____
Date

ABSTRACT

Parenting Stress and Mood Reactivity: The Role of Sleep Quality

Chelsea da Estrela

Parents of children with autism spectrum disorder (ASD) experience more stress and depressive symptoms than other parents. These parents are also at risk for sleep disturbances. Given that experimental studies indicate that sleep deprivation impairs emotion regulation, poor sleep may increase the risk for mood disturbances in the context of chronic parenting stress. To better understand the role of sleep quality in the relationship between parenting stress and negative mood, 66 parents of children with ASDs completed self-report measures of daily parenting stress, negative mood, and sleep quality (e.g., sleep efficiency, sleep satisfaction) for six consecutive days. Participants also completed a questionnaire assessing depressive symptoms over the previous two weeks. Hierarchical linear modeling revealed that daily negative mood was predicted by between-subject differences in parenting stress, between-subject differences in sleep efficiency, and within-subject differences in sleep satisfaction. Further, sleep quality moderated the impact of parenting stress on mood. Parents who experienced more parenting stress and reported poorer sleep efficiency than other parents experienced more negative mood. Further, parents who experienced more parenting stress reported more negative mood following a night where they had poorer sleep satisfaction than usual, compared to parents exposed to less parenting stress. Sleep satisfaction also fully mediated the relationship between parenting stress and depressive symptoms. Consistent with theories of the emotion regulation function of sleep, sleep disturbances may diminish parents' ability to cope with the daily challenges of living with a child with ASD, thereby exacerbating the association between daily stress and negative mood. Further, high parenting stress may increase the impact of transient sleep disturbances on mood.

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Chronic stress is associated with a number of negative physical and mental health outcomes (Schneiderman, Ironson, & Siegel, 2005). Exposure to repeated psychosocial stress disrupts activities of daily living, including sleep quantity and quality (Kim & Disdale, 2007). Sleep is a basic biological process that is important for regulating a number of neurobiological and physiological activities (Rechtschaffen, 1998). In particular, sleep is important for emotion regulation (Goldstein & Walker, 2014; Hall, Levenson, & Hasler, 2012). That is, sleep impacts emotional responses to stressors such that decreased sleep is associated with increased negative mood in response to a range of stressful tasks (Minkel et al., 2012; Zohar, Tzischinsky, Epstein, & Lavie, 2005). Poor sleep is thus a potential mechanism linking chronic stress with psychological distress. Indeed, populations wherein sleep is regularly disrupted such as shift workers, police officers, medical residents, and full-time caregivers are at increased risk for the development of mood disorders (Boivin & Boudreau, 2014; Castro et al., 2009; Charles et al., 2011; Lee, 2013; McCurry, Logsdon, Teri, & Vitiello, 2007; Mansukhani, Kolla, Surani, Varon, & Ramar, 2012; Peng & Chang, 2013; Slaven et al., 2011; Zohar et al., 2005). Given these findings, the purpose of the current study is to investigate the role of sleep quality in the association between daily stress and negative mood among individuals facing chronic parenting stress.

Chronic Parenting Stress and Sleep

Parents of children with an autism spectrum disorders (ASD) face exceptional parenting challenges throughout their child's life. They report experiencing high levels of daily stress, more so than parents of typically developing children and parents of children with other special needs (Bouma & Schweitzer, 1990; Brobst, Clopton, & Hendrick, 2009; Dabrowska & Pisula,

2010; Dumas, Wolf, Fisman, & Culligan, 1991; Estes et al., 2009; Hayes & Watson, 2013; Hoffman, Sweeney, Hodge, Lopez-Wagner, & Looney, 2009; Lee et al., 2009; Pisula, 2007; Rao & Beidel, 2009; Weiss, 2002; Wolf, Noh, Fisman, & Speechlet, 1989). The core symptoms of ASDs; deficits in adaptive living skills, social functioning, language development, and behavioral problems (American Psychiatric Association, 2013), result in unique caregiving challenges for parents of children with an ASD. In particular, it is the unique array and high frequency of child behavioral problems typical of ASDs (e.g., aggression towards others, self-injurious behaviors, stereotypical and repetitive behaviors; Maskey, Warnell, Parr, Le Couteur, & McConachie, 2013) that are the strongest predictors of parenting stress in this population (Brobst et al., 2009; Bromley, Hare, Davison, & Hare, 2004; Davis & Carter, 2008; Estes et al., 2009; Falk, Norris, Quinn, 2014; Freeman et al., 1991; Hall & Graff, 2012; Karst & van Hecke, 2012; Phetrasuwan & Shador Miles, 2009; Rezendes & Scarpa, 2011; Walsh, Mulder, & Tudor, 2012). These challenging child behaviors negatively impact parent mood both cross-sectionally and prospectively (Bromley et al., 2004; Davis & Carter, 2008; Dunn, Burbine, Bowers, & Tantleff-Dunn, 2001; Estes et al., 2009; Herring et al., 2006; Jellett et al., 2015; Pottie, Ingram, & Cohen , 2009; Rezendes & Scarpa, 2011; Weiss, Cappadocia, MacMullin, Viecili, & Lunsky, 2012). Concordantly, parents of children with ASDs report more depressive symptoms than other parents (Bitsika et al., 2013; Dumas et al., 1991; Lee et al., 2009).

In addition to the chronic parenting stress and negative mood observed in this population, parents of children with ASDs also report frequent sleep disturbances (Lee, 2013). Both subjective and objective measures of sleep quality suggest that parents of children with ASDs experience poorer sleep than parents of typically developing children. These parents report poorer subjective sleep quality, longer sleep onset latency, more sleep disturbances (e.g., early

morning awakenings, nightmares, and feeling too hot or too cold), and greater daytime sleepiness than parents of typically developing children (Lopez-Wagner et al., 2008; Meltzer, 2008). Data collected from actigraphs (i.e., wrist-watches that differentiate sleep from wakefulness based on motion detectors; Jean-Louis et al., 1996) are consistent with the findings from self-report measures. Over a seven-day period, actigraphy data showed that parents of children with ASDs had earlier wake times, shorter total sleep times, and lower sleep efficiency than other parents (Meltzer, 2008). Polysomnography data with other caregiving populations, such as individuals caring for a family member with dementia, show a similar pattern of results whereby caregivers experience more fragmented sleep than noncaregivers (see Peng & Chang, 2013 for a review). Thus, both subjective and objective sleep measures suggest that parents of children with ASDs have impaired sleep quality.

Both child nighttime behavior (i.e., sleep habits) and daytime behavior (i.e., behavioral problems) are associated with parental sleep quality (Chu & Richdale, 2009; Lopez-Wagner et al., 2008; Meltzer, 2011). That is, not only are parental reports of the severity of their child's sleep problems are associated with their own self-reported sleep quality (Chu & Richdale, 2009; Lopez-Wagner et al., 2008) and their actigraphy data (Meltzer, 2011) but disruptive child behaviors throughout the day also predict poorer subjective and objective parental sleep quality (Chu & Richdale, 2009; Meltzer, 2011). Together, these findings suggest that the caregiving challenges that arise throughout the day are predictive of parental sleep quality.

Parental sleep quality is associated with a number of daytime consequences that can directly and indirectly impact parenting behaviors and practices. For instance, parents of children with ASDs report more fatigue than parents of typically developing children. The fatigue reported by these parents is predictive of poorer self-rated parental self-efficacy and parenting

satisfaction (Giallo et al., 2011). Further, poorer subjective and objective sleep quality is also associated with self-rated anxiety and perceived parenting stress, and depressive symptoms (Chu & Richdale, 2009; Meltzer, 2011). Thus, not only are these parents at an increased risk for sleep disturbances but poor sleep may put them at an increased risk for mood disturbances.

Sleep and Emotion Regulation

Emotion regulation theories of sleep argue that sleep is an important mechanism impacting emotional responses to stressors (Deliens, Gilson, & Peigneux, 2014; Goldstein & Walker, 2014; Hall et al., 2012; Meerlo, 2008). Studies using fMRI data implicate different neurobiological systems, including the amygdala and the medial-prefrontal cortex, in linking sleep and emotional reactivity. For instance, individuals show an exaggerated amygdala response to negative emotional stimuli following a night of sleep deprivation (Yoo, Gujar, Hu, Jolesz, & Walker, 2007) and an interaction between poor self-reported sleep quality and amygdala reactivity to threat-related stimuli to predict depressive symptoms (Prather, Bogdan, & Hariri, 2013). These findings are consistent with results from epidemiological studies that indicate that insomnia prospectively predicts the occurrence and reoccurrence of mood disorders (Baglioni, Spiegelhalder, Lombardo, & Riemann, 2010; Baglioni et al., 2011; Drake, Pillai, & Roth, 2014; Ohayan, 2002).

Experimental sleep deprivation studies also support the impact of sleep impairment on mood disturbances. Participants who were sleep-deprived for one night reported greater subjective stress, anger, anxiety, and fatigue in response to a cognitive task as compared to participants who were given the opportunity to sleep (Minkel et al., 2012). Further, in a study where participants were explicitly instructed to cognitively reappraise the event they viewed (i.e., reframe the situation in a more positive way), those reporting poor sleep quality over the past

week experienced more sadness in response to an emotional video clip indicating that poor sleep interfered with these participants' ability to regulate their negative mood (Mauss, Troy, & LeBourgeois, 2013).

Sleep patterns of individuals experiencing chronic sleep disturbances are particularly variable and less predictable than sleep patterns of good sleepers (Sánchez-Ortuño, Carney, Edinger, Wyatt, & Harris, 2011). Daily diary studies, involving repeated assessment of the same individuals over the course of several consecutive days, are particularly well-suited for studying psychological processes, such as sleep quality, that are inherently variable and may fluctuate on a daily basis (Iida, Shrout, Laurenceau, & Bolger, 2012). In contrast to study designs and techniques that aggregate scores (i.e., compute an average score for each individual), daily diary designs can disentangle between-subject and within-subject effects. In the context of sleep quality and mood reactivity, daily diary studies are therefore valuable because they can provide information as to how chronic sleep disturbances (i.e., between-subject differences) and day-to-day variability in sleep quality (i.e., within-subject differences) are differentially associated with mood. This is important because it is an ecological fallacy to assume that between-subject effects are the same as within-subject effects (Bolger & Laurenceau, 2013). For example, in a daily diary study with older adults, between-subject differences in objective measures (i.e., night awakenings as calculated actigraphy data) and subjective measures (i.e., self-reported sleep quality) of sleep disturbances predicted variability in self-reported negative affect. However, only within-subject differences in subjective measures, and not objective measures, of sleep quality predicted self-reported negative affect (McCrae et al., 2008).

To our knowledge, such a design has yet to be applied to understand how sleep disturbances elicit mood disturbances in the context of parenting stress. Instead, most of the

previous findings have been derived from cross-sectional data, which does not allow for an examination of how between- and within-subject differences of how all of these variables may interact and influence one another. As parents of children with ASDs experience greater parenting stress, sleep disturbances, and mood disturbances than other parents, they also provide a unique opportunity to study how individual and intra-individual differences in sleep quality explain how individuals facing chronic stress react to the stressors they encounter in their daily lives.

Current Study

The aim of the current study was to better understand the link between daily parenting stress, sleep quality, and negative mood using a daily diary design. A daily diary approach was chosen to gain a better understanding of the between-subject and within-subject differences in parenting stress, sleep, and mood (Bolger & Laurenceau, 2013).

Given previous research highlighting the importance of sleep in the context of chronic stress and emotion regulation, it was hypothesized that sleep disturbances would exacerbate (i.e., moderate) the relation between child behavioral problems and negative mood. Specifically, we predicted that on a between-subject level, parents who on average experienced the most child behavioural problems and most sleep disturbances would report the most negative mood. On a within-subject level, we predicted that on days with increased sleep disturbances, parents' mood would be particularly sensitive to child behavioral problems. We also hypothesized that sleep quality would mediate the association between chronic parenting stress and depressive symptoms.

Method

Participants

Sixty-six participants were recruited via posters and meetings at schools and community groups for families of children with special needs in the Greater Montreal Area. Participants were the biological or legal parents cohabiting with a child with an ASD diagnosis. Table 1 presents the participants' sociodemographic characteristics.

Procedure

Participants completed background questionnaires assessing the participants' sociodemographic and family characteristics, and current depressive symptoms. Participants also completed daily diaries for six consecutive days at approximately the same time each day. The daily diaries included measures of child behavioral problems, negative mood, and sleep quality and quantity. On the first daily diary day, a research assistant administered the daily diary as a semi-structured interview over the phone with the participant to ensure that the participant was comfortable completing the questionnaires alone on the following five days. Participants were instructed to answer the subsequent daily diaries according to events that have occurred within the last 24 hours (i.e, since they completed the last daily diary). Both the background and six daily diaries were available in electronic and paper format and were completed by the participants at home.

Measures

Child behavioral problems. The problem behavior subscale of the Scales of Independent Behavior-Revised (SIB-R; Bruininks, Woodcock, Weatherman, & Hill, 1996) was used to assess the daily occurrence of child behavioral problems. Consistent with previous studies with parents of children with autism, this was used as a proxy and objective measure of daily parenting stress (Boyd, 2002; Brobst et al., 2009). The subscale listed eight behavioral problems including internalizing (e.g., "Has your child been hurtful to himself/herself?"), asocial

(e.g., “Has your child had any socially offensive behavior?”), and externalizing (e.g., “Has your child been destructive or hurtful to others?”) problem behaviors. Participants indicated whether their child with an ASD had shown a particular problem behavior in the past 24 hours. A sum of child behavioral problems was then calculated for each day.

Daily mood. Five items from the negative affect subscale of the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) were used to assess daily negative mood respectively. Participants were asked to rate the extent to which they felt a particular feeling (e.g., upset, afraid, hostile) in the past 24 hours on a 5-point scale (1 = *very slightly or not at all* and 5 = *extremely*). A sum was calculated for each day with higher scores indicative of greater negative mood.

Sleep quality. Items from the Insomnia Severity Index (ISI; Bastien, Vallières, & Morin, 2001) and the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) were used to assess daily sleep quality. According to the recommendations proposed by Buysse and colleagues (2006), a sleep efficiency score was calculated as the ratio of total sleep duration to total time in bed. Total time in bed was calculated as the time between first getting into bed at night and getting out of bed the next morning. Total sleep duration was calculated as the difference between total time in bed and sleep-onset latency (i.e., time it took participants to initially fall asleep from the moment they intended to fall asleep), duration of nocturnal awakenings (i.e., time awake after sleep onset), and duration of early morning awakenings (i.e., the time between final sleep awakening and getting out of bed). Participants also rated their satisfaction with their sleep the previous night on a 5-point scale (1 = *very satisfied* and 5 = *very dissatisfied*). Sleep efficiency and self-reported sleep satisfaction was recorded for each daily diary day.

Depressive symptoms. The Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) is a 20-item subscale that was used to assess depressive symptoms in the past week. Participants were asked to rate how many days during the past week they felt or behaved a certain way (e.g., "I thought my life had been a failure") on a 4-point scale (0 = *less than one day* and 3 = *five to seven days*). The CES-D items were summed to yield a total possible range of scores from 0 to 60. Scores above 16 are considered to be a clinically significant level of depressive symptoms. Sample-specific internal consistency for the CES-D was $\alpha = .89$.

Statistical Analyses

Hierarchical linear modeling. Hierarchical linear mixed effects modeling were used to analyze how daily parenting stress and sleep quality predicted daily mood across the daily diary period. Day of the week, parent's sex, and child's age were entered as covariates in all models.

To isolate the within- and between-person effects, the predictors (i.e., parenting stress and sleep quality) were person-mean centered and person centered, respectively (Bolger & Laurenceau, 2013. Random effects for both the intercept and slope of the average child behavioural problems effect were estimated. The interactions among the between- and within-person predictors (i.e., parenting stress X sleep quality) were used to predict daily mood. The data was analyzed using an unstructured covariance matrix and the PROC MIXED function in SAS version 9.4.

Mediation analyses. Bootstrapping of the indirect effects was used to test the hypothesis that sleep quality mediated the relation between child behavioral problems and current depressive symptoms. This method is superior to traditional tests of mediation because it does not require large sample sizes nor does it assume normal distribution of the variables (Preacher & Hayes, 2004). The PROCESS package for SPSS Version 20 developed by Hayes (2013) was

used to generate bootstrapped samples to compute confidence intervals for the estimated total, direct, and indirect effects of X on Y. Mediation was inferred if the bootstrap confidence interval (95%) for the estimated indirect effect did not include 0.

Aggregated mean scores of sleep satisfaction and sleep efficiency were entered as potential mediators in a multiple mediation model. Mean child behavioral problems across the daily diary period was used as the predictor variable (X) and frequency of self-reported current depressive symptoms was used as the outcome variable (Y). The bootstrap confidence intervals of the estimated total, direct, and indirect effects of the model were then interpreted.

Results

Prior to testing the study's hypotheses, the data was screened for data integrity purposes. To check for outliers, the data was transformed into z-scores. With respect to the aggregated scores, four data points were identified as statistical outliers (z scores > ±3.00). These data points were included in the subsequent analyses because although they represented statistical outliers, they were consistent with findings that parents of children with ASDs experience particularly high levels of parenting stress, negative affect, and sleep disturbances (e.g., Lee, 2013). Further, excluding these data points did not change the pattern of results.

To ensure that the variables of interest were normally distributed, skewness and kurtosis values were calculated for each variable. The non-aggregated and aggregated scores were not significantly skewed, however, the scores for sleep efficiency and negative affect had kurtosis scores beyond ±2.00 (4.01 and 2.47, respectively). While the mediation analysis technique chosen does not assume normal distribution of the study variables, HLM does make this assumption and as such that data should be interpreted with caution.

Descriptive Statistics and Bivariate Correlations

Table 2 describes for the range, mean, standard deviations, and intra-class correlation of the aggregated daily child behavioural problems, negative mood, sleep satisfaction, sleep efficiency, and self-reported depressive symptoms, as well as the bivariate Pearson's correlations among the main study variables. Two participants did not complete the CES-D and were subsequently dropped from the mediation analyses. Every participant completed at least three daily diaries and the average number of daily dairies completed by each participant was four. Of the 66 participants, 53% endorsed sleep disturbances that lasted longer than 30 minutes (e.g., difficulty falling asleep, staying asleep, or early morning awakenings) at least once during the daily diary period with 19.7% of the sample endorsing these sleep disturbances on three or more nights across the daily diary period.

Within- and Between-Person Analyses

Stability of study variables across the daily diary period. Intraclass correlations (ICC) were calculated to estimate the stability of the study variables across the daily diary period (See Table 2). More than half of the variance in negative mood and child behavioural problems was explained by between-person variability, indicating that negative mood and child behavioural problems were fairly stable across days. Comparatively, most of the variance in sleep satisfaction, and sleep efficiency could be explained by within-person variability indicating that sleep quality fluctuated across the daily diary period.

Parenting stress, sleep quality, and mood. Model 1 examined the within-person and between-person effects of child behavioural problems on mood. As shown in Table 3 (Model 1), between-person differences, but not within-person differences, in child behavioural problems were statistically significantly associated with daily negative mood, such that parents who on average reported more child behavioural problems experienced more negative mood than other

parents. Furthermore, there was a significant random effect (i.e., slope) to be explained. Specifically, there was statistically significant variability in the association between average child behavioural problems and daily negative mood.

To test the hypothesis that sleep quality could explain some of the variance of the association between parenting stress and mood, sleep satisfaction and sleep efficiency were added to the model as fixed effects[1]. As shown in Table 3 (Model 2), the within-subject effect of sleep satisfaction and the between-subject effect of sleep efficiency explained variability in negative mood across the daily diary period. Specifically, parents reported greater negative mood following nights when they were more dissatisfied with their sleep than usual. Similarly, parents who on average reported poorer sleep efficiency than other parents experienced greater negative mood across the daily diary period. Further, adding these sleep parameters reduced the random effects estimate of the association between average child behavioural problems and negative mood by 27.97%. Between-subject differences in sleep satisfaction, and within-subject differences in sleep efficiency did not significantly predict variability in daily negative mood.

Interactions between parenting stress and sleep quality. To test the hypothesis that sleep quality moderated the association between parenting stress and negative mood, cross-level and level 2 interaction terms were computed and entered in a model. As shown in Table 4, within-subject differences in sleep satisfaction and between-subject differences in sleep efficiency moderated the relation between average child behavioural problems and negative mood. That is, parents who on average reported more child behavioural problems than other parents showed greater increases in negative mood following a night where they were more

[1] Sleep duration was not included in the multivariate analyses because it was used in the calculation of sleep efficiency. When the models were rerun with sleep duration added to the model instead of sleep efficiency, the pattern of results remained the same. Sleep duration was not a statistically significant predictor of negative mood or depressive symptoms.

dissatisfied with their sleep than usual (Figure 1). Further, parents who on average experienced more child behavioural problems than other parents and who on average experienced poorer sleep efficiency reported more negative mood across the daily diary period as compared to parents who experienced less child behavioural problems and better sleep efficiency (Figure 2). When accounting for the two significant interactions in the model, the random effect estimate of the slope of average child behavioural problems was reduced by 71.76% as compared to the previous model and 79.66% as compared to the baseline model and no longer statistically significant. The other interactions among parenting stress and sleep quality were non-significant and trimmed from the model.

Mediation Analyses

Multiple mediation using the bootstrapping of the indirect effects methods by Preacher and Hayes (2004) was used to test the hypothesis that sleep quality mediated the link between chronic parenting stress and depressive symptoms. To better understand the chronic effect of parenting stress and poor sleep quality, the daily assessments of parenting stress, sleep satisfaction, and sleep efficiency were aggregated across the daily diary period for each participant. Depressive symptoms in the past two weeks were assessed retrospectively. Parent's sex and child age were added to the model as covariates. The results of the mediation analysis are presented in Figure 3. The estimated total effect of mean child behavioural problems on self-reported depressive symptoms was statistically significant. After adjusting for sleep satisfaction and sleep efficiency, the direct effect of mean child behavioural problems on self-reported depressive symptoms was no longer statistically significant. Interpretation of the 95% confidence intervals around the estimates of the indirect effects for each mediator supported the hypothesis that sleep satisfaction (95% CI [.12, 2.20]), but not sleep efficiency (95% CI [-.43, 1.01]),

mediated the relation between mean child behavioural problems and self-reported depressive symptoms. This model accounted for 22% of the variance in self-reported depressive symptoms ($R^2 = .22$).

Discussion

The purpose of the current study was to examine the role of sleep quality in the association between parenting stress and negative mood. Using a daily diary design, the results from the current investigation indicate that sleep quality explains a significant amount of the variability (i.e., up to 79.6%) that exists between average child behavioural problems and negative mood. Specifically, the fixed effects of within-person differences in parent sleep satisfaction and between-person differences in parent sleep efficiency helped explain the association between average child behavioural problems and parent daily negative mood (i.e., the random effect). Analysis of the fixed effects also showed that these differences in sleep quality moderated the relation between average child behavioural problems and negative mood. For instance, parents who on average reported more child behavioural problems than other parents, experienced greater negative mood following nights when they were more dissatisfied with their sleep than usual. Further, parents who on average reported more child behavioural problems and on average poorer sleep efficiency than other parents, experienced more negative mood across the daily diary period as compared to parents who reported less parenting stress and better sleep efficiency. Moreover, results from the cross-sectional mediation analyses indicated that sleep satisfaction, but not sleep efficiency, fully mediates the relationship between child behavioural problems and self-reported parental depressive symptoms, highlighting the importance of subjective sleep quality.

These results are consistent with previous findings that parents of children with autism spectrum disorder experience a number of sleep disturbances that are associated with daytime parenting stressors and subsequently contribute to poor psychological well-being (Lee, 2013). Further, the results from the current study are also consistent with previous studies that have investigated the relationship between sleep quality and mood in the context of other parenting and caregiving populations. For instance, cross-sectional analyses of parents of children with chronic illnesses (Meltzer & Booster, 2016), first-time mothers during the post-partum period (Calcagni, Bei Bei, Milgrom, & Trinder, 2012), and family caregivers of patients with dementia (Beaudreau et al., 2008) find similar patterns of results whereby objective, and in particular subjective, markers of sleep quality predict self-reported frequency of depressive symptoms. However, the current findings build on the previously existing literature by highlighting the importance of isolating the between- and within-person effects of stress and sleep on negative mood within the context of chronic stress.

Consistent with the findings from the current study, sleep disturbances are a strong predictor of mood disturbances. Data from a recent meta-analysis of longitudinal epidemiological studies suggest that insomnia is one of the best predictors of future depressive episodes, indicating that non-depressed individuals with insomnia were at a two-fold risk for experiencing a depressive episode as compared to non-depressed individuals without insomnia (Baglioni et al., 2011). Findings from intervention studies also point towards an important link between sleep quality and mood disturbances. Specifically, treatments explicitly targeting insomnia symptoms (e.g., cognitive-behavioural therapy for insomnia) have been effective in reducing sleep disturbances *and* depressive symptoms (Ashworth et al., 2015; Manber et al., 2008; Norrell-Clarke, Jansson-Fröjmark, Tillfors, Holländare, & Engström, 2015), highlighting

that sleep disturbances play a key role in the development and maintenance of depressive disorders.

Chronic stress exposure also increases the risk for mood disturbances. Longitudinal studies provide strong evidence that chronic life stressors precipitate the development of mood disorders and may play a causal role in the onset of major depression (see Hammen, 2005 for a review). Indeed, the demands and responsibilities associated with caregiving for a loved one with a chronic illness are conceptualized as chronic stressors; caregivers report elevated depressive symptoms as compared to matched noncaregiving controls (Pinquart & Sörensen, 2003). Further, the impact of daily stressors on mood is amplified in context of chronic stress (Serido, Almeida, & Wethington, 2004). This suggests that as parents of children with ASDs experience above-average levels of sleep disturbances and stress compared to other parents, they may be at an especially high risk for mood disturbances.

Indeed, current models of sleep and emotional regulation propose different ways in which sleep and mood could be related *within* the context of chronic psychosocial stress (Goldstein & Walker, 2014). For instance, the current finding that parents who report on average more parenting stress are particularly sensitive (i.e., report more negative mood the next day) to daily changes in sleep satisfaction, is consistent with the hypothesis that the effects of transient sleep disturbances on mood are more pronounced within the context of chronic stress. For example, studies using an academic stress model have shown that students reporting high levels of baseline stress are particularly vulnerable to sleep disturbances during high stress periods (i.e., exam period; Dewald, Meiher, Oort, Kerkhof, & Bögels, 2012). Further, the compensatory effect of sleep efficiency is less robust during these high stress periods as compared to low stress periods (Astill, Verhoeven, Vijzelaar, & van Someren, 2013), such that after a night of shorter

sleep than usual there was no evidence of the typical compensatory increase in sleep efficiency or subjective sleep quality the following night.

Another conceptualization is that sleep is a necessary resource to cope with stressors. Zohar and colleagues' cognitive-energy model (2003) posits that self-regulation, including emotional regulation in the face of mild stressors, requires a considerable amount of cognitive resources. Further, the cognitive-energy model suggests that sleep loss diminishes the amount of cognitive energy available and thereby interferes with individuals' ability to self-regulate. This model is consistent with findings from the current study that highlight how parents who experience more child behavioural problems and poorer sleep efficiency than other parents experience more negative mood than parents who experience less stress and who are better sleepers. Following this conceptualization it is thus possible that parents who experience the most sleep disturbances are less able to cope with the daily challenges associated with parenting a child with ASD and as a consequence experience more negative mood than parents whose sleep is less disturbed.

Further, the literature also suggests a bidirectional relationship between sleep and stress wherein not only does sleep impact how people react to stress, but that stress impacts individual's vulnerability to sleep disturbances. Consistent with our finding that parenting stress was indirectly associated with depressive symptoms via sleep quality, chronic stress could interfere with individuals' ability to sleep and subsequently impact their daytime functioning and create more stress. For instance, a seminal study by Kant and colleagues (1995) using rat models showed how chronic stress can lead to sleep disturbances. Studies with human models have yielded similar results. Psychosocial stress affects objective markers of sleep, such as more fragmented sleep, less REM sleep (Kim and Dimsdale, 2007). Despite known individual

differences in vulnerability to stress-induced insomnia (Drake et al., 2014), studies indicated that chronic caregiving stress is consistently associated with sleep disturbances (Kim & Dimsdale, 2007). Further, a review by Meerlo and colleagues (2008) highlighted the possibility that chronic sleep deprivation could then eventually alter the sensitivity of individuals' neuroendocrine stress systems to make them more vulnerable to stressors. This cyclical process may thus increase one's risk for depression.

The main strength of the current study is its use of a daily diary design to examine the between- and within-subject effects of sleep quality on mood disturbances in the context of chronic parenting stress. Previous studies using cross-sectional analyses and aggregated data cannot tease apart these effects. As discussed above, *within*-subject differences in sleep satisfaction and *between*-subject differences in sleep efficiency were important to consider, such that only these effects in particular explained variability in parental negative mood. Further, the current study operationalized and measured parenting stress (i.e., frequency of child behavioural problems) as opposed to previous studies that inferred parenting stress based on caregiver status. However, limitations of the current study include the possibility that parents' current day mood biased how they remembered their previous night's sleep quality. That is, since participants reported on previous night's sleep quality at the end of the following day it is possible that their mood throughout the day impacted how they perceived their sleep quality. This could be particularly true for sleep satisfaction, which is a subjective measure of sleep quality. Future studies could assess previous night's sleep at the beginning of the following day to rule out this possibility. Actigraphy should also be used to obtain an objective assessment of the sleep-wake cycles. Further, while a mediation effect of sleep quality on depressive symptoms was observed in the current study, these results were derived using cross-sectional data. To strengthen the

hypothesis that parenting stress is related to depressive symptoms via poor sleep quality, a longitudinal analysis of these variables using multiple time points is warranted.

Together the findings from the current study have important implications for the chronic stress and sleep literature. The current investigation highlights that sleep quality is an important risk factor and mechanism that can place individuals already at an increased risk for mood disturbances at an even greater risk for psychiatric problems. Further, it highlights how both chronic sleep disturbances and daily fluctuations in sleep quality can affect how people function and respond to stressors in their day-to-day lives.

From a developmental perspective these results also provide evidence that child functioning can impact parental functioning. For instance, while there is a large body of literature that supports the hypothesis that parent functioning impacts child functioning (e.g., the effects of maternal depression on child development; Murray, 2004), there is a growing body of literature that posits that children also have an impact on their parents in a reciprocal manner (e.g., Gross, Shaw, Moilanen, Dishion, & Wilson, 2008). By demonstrating that child behavioural problems interact with and predict parental sleep quality to explain parental mood, the current study adds to this body of literature. Further, these reciprocal models of parenting and child behaviours highlight how parent functioning could impact child functioning and vice versa in a cyclical pattern of stress and distress thereby highlighting the need for intervention studies.

While child behavioural problems, especially within the context of an autism spectrum diagnosis, may be particularly resistant to change, there currently exist a number of effective interventions for sleep disturbances which may allow mental health professionals to help families better face these challenges by enhancing their sleep quality. Cognitive-behavioural therapy for insomnia (CBT-I) is currently the gold standard treatment for sleep disturbances (Trauer, Qian,

Doyle, Rajaratnam, & Cunnington, 2015). In a recent pilot study, new mothers at-risk for post-partum depression participated in a CBT-I program and reported fewer depressive symptoms at post-treatment as compared to pre-treatment (Swanson, Flynn, Adams-Mundy, Armitage, & Arnedt, 2013). Future research should therefore examine the effects of CBT-I and other sleep interventions on daytime functioning and wellbeing of parents and other caregivers facing extraordinary caregiving demands. Given the results of the current study and previous literature on chronic stress and sleep it is possible that interventions targeting sleep quality would thus enable parents and other family caregivers to better cope with the daily stressors associated with caregiving to subsequently yield a more resilient and positive family system.

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Table 1. *Participants' sociodemographic and family characteristics (N = 66)*

		n (%)/ *M* ±*SD*
Sex (Female)		54 (81.8)
Age (Years)		42.7 ±6.89
Ethnicity (Caucasian)		40 (60.6)
Education		
	Not Reported	1 (1.5)
	≤ High School	11 (16.7)
	College	42 (63.6)
	Graduate Degree	12 (18.2)
Household income		
	≤ $49,999	22 (33.3)
	$50,000 - $69,999	17 (25.8)
	$70,000 - $89,999	13 (19.7)
	≥ $90,000	14 (21.2)
Child's age (Years)		10 ±5.11
Child's diagnosis		
	Autism	53 (80.3)
	Pervasive Developmental Disorder	8 (12.1)
	Asperger's Syndrome	5 (7.6)

Table 2. *Descriptive statistics and Pearson correlations amongst main study variables*

	1	*2*	*3*	*4*	*5*
1. Child behavioural problems	-	.33**	-.30**	.52**	.30*
2. Sleep (dis)satisfaction	-	-	-.50**	.28*	.42**
3. Sleep efficiency	-	-	-	-.47**	-.28**
4. Negative mood	-	-	-	-	.33**
5. Depressive symptoms	-	-	-	-	-
Mean (SD)	2.40 (1.60)	1.79 (.81)	.83 (.11)	8.62 (3.37)	18.37 (10.84)
Range	0-7.67	0-3.60	.42-.98	5-25	0-45
ICC	.62	.27	.36	.58	-

Note. With the exception of self-reported depressive symptoms measured with the CES-D, all variables were derived from computed mean scores for each participant across the daily diary period. ICC = intraclass correlation. * $p < .05$, ** $p < .01$, ' $p < .10$

Table 3. *Mixed-effects model of average child behavioural problems and parent sleep quality in predicting negative mood*

	Model 1 *Estimate (SE)*	Model 2 *Estimate (SE)*
Fixed effects		
Intercept	6.02 (1.22)**	13.33 (3.81)**
Day	-.09 (.07)	-.12 (.07)'
Parent's sex	-.54 (.86)	-.75 (.86)
Child's age	.08 (.07)	.08 (.07)
Daily child behavioural problems	.10 (.13)	.07 (.13)
Average child behavioural problems	.87 (.29)**	.83 (.28)**
Daily sleep satisfaction		.38 (.16)*
Average sleep satisfaction		-.24 (.49)
Daily sleep efficiency		-.79 (1.37)
Average sleep efficiency		-7.78 (3.49)*
Random effects		
Intercept	10.23 (4.95)*	9.25 (4.40)*
Average child behavioural problems	1.18 (.68)*	.85 (.60)'
Residuals	7.39 (.58)**	7.23 (.57)**

Note. * $p < .05$, ' $p < .10$. With respect to the *day* variable, all participants started the daily diary period on Monday and the first daily diary was coded as "1", therefore as the *day* variable increased so did the closeness to the weekend.

Table 4. *Mixed-effects model testing the interaction between child behavioural problems and parent sleep quality in predicting negative mood*

	Model 3 *Estimate (SE)*
Fixed effects	
Intercept	.83 (4.95)
Day	-.11 (.07)'
Parent's sex	-.48 (.85)
Child's age	.10 (.06)
Daily child behavioural problems	.01 (.12)
Average child behavioural problems	4.92 (1.28)**
Daily sleep satisfaction	-.38 (.23)'
Average sleep efficiency	6.32 (5.68)
Average child behavioural problems X Daily sleep satisfaction	.33 (.07)**
Average child behavioural problems X Average sleep efficiency	-5.00 (1.59)**
Random effects	
Intercept	7.18 (3.97)*
Average child behavioural problems	.24 (.35)
Residuals	6.83 (.54)**

Note. * $p < .05$, ** $p < .01$, ' $p < .10$

Figure 1.

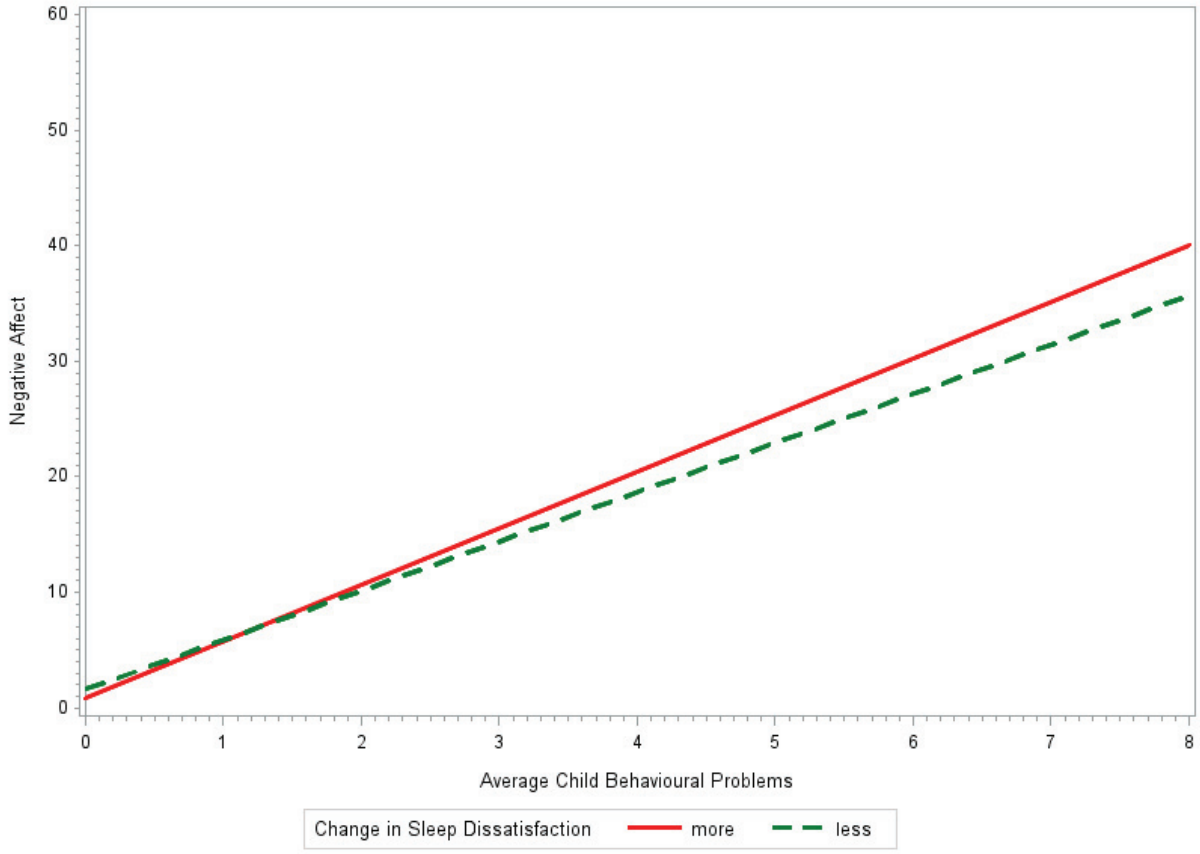

Figure 1. Visual depiction of the interaction of between-subject differences in child behavioural problems with within-subject differences in sleep satisfaction. The lines depicted represent ± 1 SD around the mean of person-centered change in sleep satisfaction.

Figure 2.

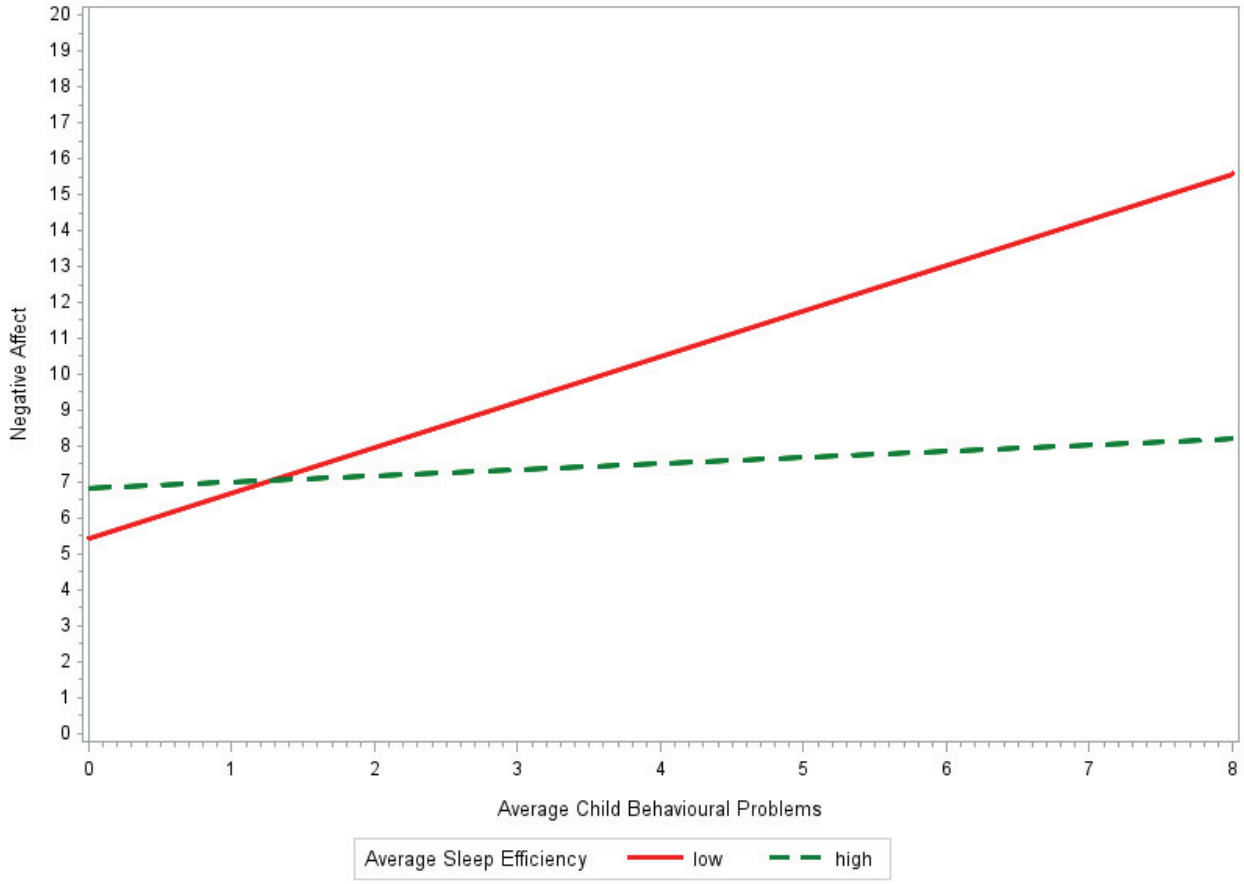

Figure 2. Visual depiction of the interaction between between-subject differences in child behavioural problems and between-subject differences in sleep efficiency. The lines depicted represent ± 1 SD around the mean of sleep efficiency.

Figure 3.

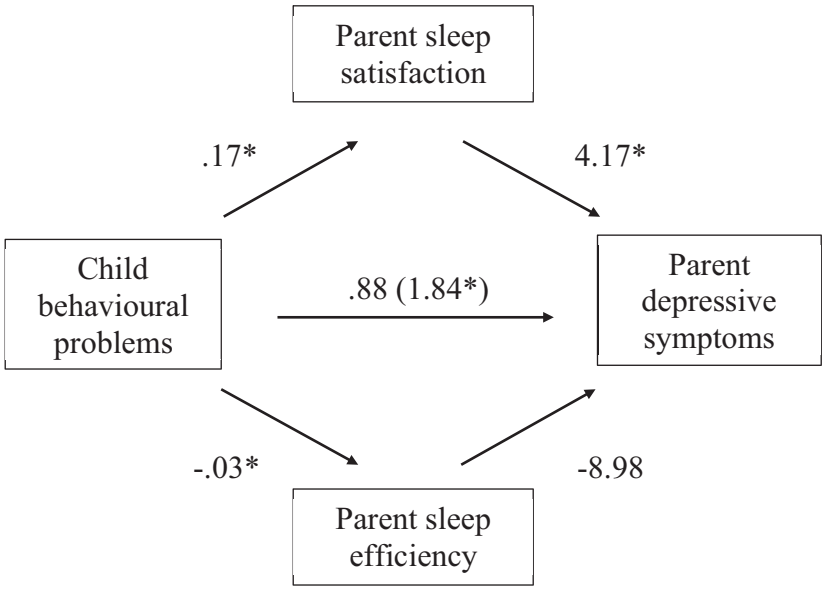

Figure 3. Visual depiction of the multiple mediation model showing the estimated paths between the predictor, mediators, and outcome variables. All variables, with the exception of parent depressive symptoms, represent mean scores derived across days from the daily diary questionnaires. The total effect of child behavioural problems on parent depressive symptoms is shown inside of the parentheses and the direct effect is shown outside of the parentheses. * $p <$ .05