CHILDHOOD SLEEP PROBLEMS AS PREDICTORS OF ADOLESCENT

INTERNALIZING SYMPTOMS: THE INTERMEDIARY ROLE OF EMOTIONAL

REACTIVITY

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A Thesis

Presented to

The Faculty of the Department

of Psychology

University of Houston

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In Partial Fulfillment

Of the Requirements for the Degree of

Master of Arts

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By

Katharine C. Reynolds

April 15, 2014

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ABSTRACT

Persistent sleep problems in childhood are predictive of internalizing problems in adolescence (e.g., anxiety and mood disorders), yet limited longitudinal data exist examining the specific types of sleep problems that forecast adolescent internalizing symptoms. Furthermore, possible mechanisms linking these problems over time has received limited empirical attention. The current study examined predictive relations between bedtime and middle of the night sleep problems during third grade and internalizing problems at age fifteen. The mediational role of emotional reactivity in fifth grade (i.e., during pre-adolescence) also was examined. **Method**: Participants (N=1085) were recruited as part of a large multi-site NICHD study assessing child health and development. Mother reported sleep problems (bedtime problems and nighttime waking problems) during third grade, emotional reactivity during fifth grade, and internalizing symptoms at age fifteen were entered into a series of regression-based Ordinary Least Squares (OLS) process models. Conditional process analyses were used to predict direct and indirect effects of child sleep problems on adolescent internalizing problems through emotional reactivity. Sex was examined as a moderator of mediational models. **Results**: Bedtime sleep problems, but not nighttime waking problems, were a significant predictor of adolescent internalizing problems. For girls, but not boys, emotional reactivity in fifth grade partially explained the relationship between bedtime problems and internalizing problems in adolescence. **Conclusion**: Longitudinal associations between childhood sleep difficulties and later internalizing problems appear to vary based on the nature of sleep disturbance. Specifically, problems before the sleep period but not during the

sleep period predict later internalizing problems, suggesting that later anxiety may be preceded by behavioral problems possibly related to bedtime anxiety in youth. Findings also suggest that higher levels of emotional reactivity in late childhood/early adolescence serve as a mechanism through which these problems are linked for girls only. These results add to a growing literature underscoring the reciprocal relations between sleep and emotional functioning across development. Limitations of the study and implications for future research and clinical practice are discussed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHILDHOOD SLEEP PROBLEMS AS PREDICTORS OF ADOLESCENT

INTERNALIZING SYMPTOMS: THE INTERMEDIARY ROLE OF EMOTIONAL

REACTIVITY

An adequate amount of sleep is essential for healthy development and overall

functioning (Dahl, 1996). By two years of age, a child has spent almost 14 months of his or

her life asleep (Anders, Sadeh, & Appareddy, 1995). By early elementary school, children

have spent more time asleep than participating in social interactions, playing, eating, or in

other waking activities (Dahl, 1996). Adults, on the other hand, need between seven to nine

hours of sleep per night, with observed average sleep rates falling just over six hours per

night (Lauderdale et al., 2006). The predominance of sleep early in life underscores its

critical role in brain and physical development. Further, animal research has demonstrated

that rats completely deprived of sleep survive approximately the same amount of time as rats

deprived of food (Everson, Bergmann, & Rechtschaffen, 1989). Although the specific

restorative mechanisms at work during sleep may not be understood, research has

demonstrated that many human systems and processes are closely linked to sleep.

Sleep deprived adults display significantly worse cognitive performance, motor

performance, and mood, but negative effects on mood are greatest of the three domains

(Pilcher & Huffcutt, 1996). Such findings suggest that sleep is closely linked with brain

regions responsible for regulating affect. In particular, sleep impacts the prefrontal cortex

(PFC), an area that modulates emotional responses (Bechara, Damasio, Damasio, & Lee,

1999; Bechara, Damasio, Tranel, & Damasio, 1997) via top-down control of the limbic

system (e.g., Yoo, Gujar, Hu, Jolesz, & Walker, 2007). Given the decline in total sleep

needed from infancy to adulthood (Gregory & O'Connor, 2002), with parallel growth in the

PFC throughout childhood and adolescence, it is conceivable that the effects of sleep deprivation may be increasingly negative for children.

Developmentally, the process of sleep is complicated and highly vulnerable. Two major changes that occur in humans are the shift from multiphasic sleep (i.e., sleep that is distributed across the day) to monophasic sleep (i.e., sleep that is collapsed into one nocturnal period; Sadeh, Raviv, & Gruber, 2000) and the gradual reduction in sleep need across development, accompanied by longer periods of wakefulness (Sadeh et al., 2000). In addition to developmental variations, individual sleep patterns are shaped by a range of biological and social factors such as culture, socioeconomic status, parental factors, and pubertal status. Thus, determination of healthy versus problematic sleep in childhood requires considerations of a range of factors.

It is estimated that 20-30% of children will experience sleep problems in the first three years of life (Mindell, 1993; Sadeh & Gruber, 1998). In school aged children, parents report that up to 43% of children have some type of sleep problem, and 14% of children in this age range report a problem themselves (Kahn et al., 1989). When measured objectively using actigraphy (activity based sleep monitoring collected via a small wrist-watch-like unit) older school-aged children (i.e., adolescents) show delayed sleep onset times, shorter sleep periods, and shorter total sleep times than do young school-aged children (Sadeh et al., 2000). Additionally, females in this same sample had longer total sleep times, with a greater percentage of motionless sleep than did males (Sadeh et al., 2000). When poor sleep is objectively defined (i.e., a sleep percentage less than 90 or an average of three or more nighttime wakings per night) Sadeh, Raviv, and Gruber (2000) found that 17.9% of healthy, school-aged children have sleep problems. Periodic sleep problems in children can cause

temporary impairments in academic or occupational achievement (Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010), emotional and behavioral domains (Pesonen et al., 2010), family functioning (Bell & Belsky, 2008; Simard, Nielsen, Tremblay, Boivin, & Montplaisir, 2008), and neuropsychological abilities (Carskadon, Harvey, & Dement, 1981). The consequences of long-term sleep problems are even more alarming.

Sleep and Psychopathology

In both the child and adult literatures, sleep problems forecast the onset of depression (e.g. Riemann & Voderholzer, 2003) and anxiety (e.g. Breslau, Roth, Rosenthal, & Andreski, 1996; Ford & Kamerow, 1989). Sleep problems in childhood are a robust predictor of behavioral and emotional impairment in adolescence (Gregory & O'Connor, 2002). In clinically anxious and depressed youth, rates of sleep disturbance have been estimated at 55% and 72.7%, respectively (Alfano, Ginsburg, & Kingery, 2007; Liu et al., 2007). Although sleep disruption is included in the diagnostic criteria for many internalizing disorders (*DSM-5*, 2013), evidence for a *bidirectional* relationship also exists (Cousins et al., 2011; Fuligni & Hardway, 2006).

Demonstrating this longitudinal link between sleep and psychological problems, Ong and colleagues (2006) found that sleep and eating problems in early childhood are predictive of adolescent mood and anxiety disorders, but not adult internalizing disorders (Ong et al., 2006). Similarly, Gregory and colleagues (2005) reported that persistent child sleep problems predicted later anxiety disorders, but not depressive disorders after controlling for internalizing problems in childhood, sex, and SES (Gregory et al., 2005). In a similar large twin study, sleep problems at three to four years of age modestly predicted behavioral and emotional problems at seven years of age, with stronger rates of prediction for anxiety related

problems, over conduct and hyperactivity related problems (Gregory, Eley, O'Connor, & Plomin, 2004). There is some evidence that sleep problems in later childhood may be more predictive of future problems than sleep problems emerging early in childhood (Gregory & O'Connor, 2002; Ong et al., 2006). Thus, development may moderate linkages between sleep problems and later psychological problems (Gregory & O'Connor, 2002). In teenagers, similar patterns emerge. Cross sectional data support a link between sleep problems (i.e. sleepiness), low levels of self-esteem, and increased depressive symptoms (Fredriksen, Rhodes, Reddy, & Way, 2004). Additionally, longitudinal examinations indicate that students who experienced less sleep over time (sixth grade to eighth grade) also experienced heightened depressive symptoms and decreased self-esteem (Fredriksen et al., 2004).

Assessment of "Sleep Problems"

Although available data demonstrate that childhood sleep problems increase risk for psychological problems, the vague and unreliable nature of the term 'sleep problems', as is typically used in the literature, disallows a more precise understanding of these relations. For example, in studies examining the longitudinal impact of sleep on later emotional/behavioral functioning, sleep-related items from the Child Behavior Checklist (CBCL; Achenbach, Howell, Quay, & Conners, 1991) are frequently examined. However, because these items assess a range of sleep-related problem and behaviors (e.g., nightmares, sleeping more or less than most children, talking/walking during sleep, trouble sleeping, and feeling overtired) the predictive contribution of each individual type of sleep problem is unknown (Gregory & O'Connor, 2002).

Similarly, Ong, Wickramaratne, Tang and Weissman (2006) used the sleep subscale from the Dimensions of Temperament Survey (Lerner, Palermo, Spiro, &

Nesselroade, 1982) which includes questions that assess consistency of child wake and sleep times, movement during sleep, and consistency of child sleepiness. Gregory, Eley, O'Connor and Plomin (2004) used a 4-item parent questionnaire in their study of preschool sleep problems. Items on this scale assessed for trouble falling asleep, frequent wakings, nightmares, and early morning wakings. Finally, other studies have assessed 'sleep problems' based on child report of trouble falling asleep, nighttime awakenings (where the child finds it difficult to return to sleep), a recent increase in amount of sleep, and early morning awakening (Gregory et al., 2005). Although results from these studies have increased understanding of the negative impact of overall sleep disruption on psychopathology, examination of *specific* types of sleep problems that predict later emotional functioning is imperative for moving the field forward, specifically to facilitate the development and implementation of effective intervention techniques.

Sleep & Emotional Functioning

Research focused on the link between sleep and emotion has been largely limited to adult samples. A meta-analysis of studies revealed that sleep deprived adults displayed significantly worse cognitive performance, motor performance, and mood; however negative effects on mood are greatest (Pilcher & Huffcutt, 1996). When asked to sleep only five hours per night for one week, healthy adults showed progressively worsening mood (Dinges et al., 1997). Another study examining brain function after 24 hours of sleep deprivation reported a 60% increase in amygdala activity (a brain region linked with emotion) in response to emotional stimuli (Yoo et al., 2007). In comparison to rested adults, sleep deprived individuals also demonstrated decreased activation in the prefrontal cortex, a brain region linked with the modulation of emotional responses and known to exert top-down control on

the limbic system (Bechara et al., 1999; Bechara et al., 1997). Taken together, available data indicate that sleep loss impairs appropriate reaction to emotional stimuli. Further, the effects of sleep deprivation may be even greater in children, as brain development, especially in the area of the prefrontal cortex, is not yet complete (Casey, Giedd, & Thomas, 2000).

A limited but growing body of work has begun to extend this research to younger age groups, with similar results. In toddlers, mild amounts of sleep restriction resulted in significant decreases in positive emotional responses, and significant increases in negative emotional responses (Berger, Miller, Seifer, Cares, & Lebourgeois, 2012). In healthy children, emotional intensity, measured by vagal tone and parent report, predicted sleep problems (El-Sheikh & Buckhalt, 2005). Specifically, El-Sheikh and Buckhalt (2005) found increased emotional intensity and lower levels of vagal suppression were linked with sleep problems, reduced amounts of sleep, and increased night-time activity. In adolescence, decreases in positive affect are observed after only one night of partial sleep deprivation (Talbot, McGlinchey, Kaplan, Dahl, & Harvey, 2010).

Although experimental data in adults as well as children reveal even mild amounts of sleep loss to produce acute negative changes in affect and emotional reactivity, the mechanisms by which childhood sleep problems lead to psychopathology over the long term (i.e., during the adolescent and adult years) remain less clear. The current study aimed to address this significant gap by examining emotional reactivity as a potential mediator of relationships between childhood sleep problems and anxiety/depressive symptoms at age 15.

Emotional Processing as a Mechanism linking Sleep and Psychopathology

Emotion Regulation Model. Gross' (1998) process model of emotion regulation presents five points at which emotion can be regulated: selection of the situation,

modification of the situation, deployment of attention, change of cognition, and modulation of responses. However, emotion regulation in infancy and childhood relies heavily on the caregiver (Sroufe, 2000) as well as the child's control of underlying physiological arousal (Sethi, Mischel, Aber, Shoda, & Rodriguez, 2000). Per Gross' model, emotional cues in the environment give rise to the individual's evaluation of the situation, followed by the individual's emotional response tendencies, which may be behavioral, experiential, or physiological. These tendencies are then further modulated by the individual, yielding the final product of one's observed 'emotional responses' (Gross, 1998).

Since emotion regulation is largely considered an internal process not readily observed by others, researchers often focus on more observable behavioral components of emotion regulation, such as emotional reactivity. Emotional reactivity is defined as the observable reactions of an individual in the context of external events, as rated subjectively by an observer (i.e., parent). Although not included in the current study, emotional reactivity has also been examined based on an individual's physiological reactions (e.g., heart rate, skin conductance, etc.) to specific events. Like sleep, patterns of emotional reactivity change across development. That is, a child's observed emotional reactivity and overall emotion regulatory abilities are highly dependent upon stage of physiological, attentional, behavioral, and cognitive development (Calkins & Hill, 2007), all of which may differ per one's developmental stage.

Emotional Processing and Psychopathology. Difficulty regulating emotions is a core feature of most psychiatric conditions (Derryberry, Reed, & Pilkenton-Taylor, 2003). At any age, problems with emotion regulation can negatively impact interpersonal interactions and emotional responses to environmental demands. Appropriate emotional regulation abilities

allow correct inferences to be drawn in interpersonal interactions and for the display of appropriate emotional responses across environments (Fine, Izard, Mostow, Trentacosta, & Ackerman, 2003). Children with internalizing disorders report greater levels of emotional intensity and fewer strategies for regulating their emotions than do healthy children (Suveg & Zeman, 2004). Even among healthy adolescents, those who report increased emotional lability and less effective emotion regulation skills experience higher levels of depressive symptoms (Silk, Steinberg, & Morris, 2003). Further, heightened levels of emotional reactivity and decreased regulatory control over emotional responses are thought to represent potent risk factors for affective problems (Joormann, Talbot, & Gotlib, 2007; Suveg & Zeman, 2004).

Sleep, Emotional Processing, and Psychopathology. Despite research linking sleep to later internalizing problems and disorders in both children and adults (Breslau et al., 1996; Ford & Kamerow, 1989; Fredriksen et al., 2004; Gregory et al., 2005; Gregory, Caspi, Moffitt, & Poulton, 2009; Gregory et al., 2004; Gregory & O'Connor, 2002; Ong et al., 2006; Riemann & Voderholzer, 2003), the mechanisms of this longitudinal link are largely understudied and relatively unknown. Although sleep deprivation studies are useful for understanding the acute effects of sleep loss on emotional outcomes, one night of sleep deprivation does not lead to permanent changes in emotional processing. However, studies of individuals with persistent sleep problems during early childhood suggest development may alter neurobiological mechanisms and associated aspects of emotional processing and in turn increase risk for later internalizing problems and disorders. The current study aimed to test this hypothesis by examining the mediational role of emotional reactivity in middle childhood on the relationship between sleep problems (i.e., bedtime problems and nighttime

8

waking problems) in early childhood and internalizing problems in adolescence. A *mediator* is defined as a process that accounts for the relation between an independent variable (IV) and a dependent variable (DV) (Kraemer, Kiernan, Essex, & Kupfer, 2008), or *why* the relation between an IV and DV exists. A mediator is deemed significant when the indirect effects of the IV on the DV through the mediator are significantly greater than the direct effects of the IV on the DV (Hayes, 2013).

Sex and Sleep

In adult populations, differences in sleep based on sex are well documented. Generally, women sleep more than men and experience higher rates of insomnia (Tonetti, Fabbri, & Natale, 2008; Zhang & Wing, 2006). Pubertal status also significantly impacts sleep patterns and sleep related problems including a predictable shift in circadian phase with the onset of puberty (Díaz-Morales, de León, & Sorroche, 2007; Knutson, 2005; Roenneberg et al., 2004; Werner, Lebourgeois, Geiger, & Jenni, 2009; Yang, Kim, Patel, & Lee, 2005). Because pubertal timing occurs earlier in girls than in boys (Herman-Giddens et al., 1997) sex differences may also interact with puberty-based changes in sleep such that girls may experience disrupted (i.e., delayed) sleep patterns earlier than boys (Campbell, Neill, & Lory, 2012; Montgomery-Downs, O'Brien, Gulliver, & Gozal, 2006). Overall, early adolescence (12-15 years) has been identified as an important period of risk for sleep problems (Campbell et al., 2012).

Based on sleep differences in males and females and documented sex differences in internalizing problems during adolescence and adulthood (Angold, Costello, & Worthman, 1998; Campbell et al., 2012; Hankin et al., 1998; Mezulis, Priess, & Hyde, 2011; Tonetti et al., 2008) sex was expected to differentially impact the links between sleep problems,

emotional reactivity and internalizing problems, with females at greater risk than males for internalizing problems in adolescence. Thus, the current study examined sex as a *moderator* of the relationhips of interest. A *moderator* is defined as a preexisting factor that determines which individuals at one level of an IV will perform better or worse on a DV (Kraemer et al., 2008). Further, a moderator is defined as a variable that modifies the form or strength of a relationship between and IV and DV (MacKinnon, 2008). Sex was examined as both a simple moderator and as a moderator of the proposed mediational model.

<u>Aims and Hypotheses of the current study</u>

   <u>Aim 1.</u> Using archival data, the current study aimed to accomplish three primary objectives. First, we examined (1) bedtime problems and (2) nighttime waking problems in a large, representative sample of children enrolled in the third grade. Childhood bedtime problems and nighttime waking problems were examined as separate predictors of internalizing problems in adolescence (at age 15). As previous research lacks comparisons in terms of the predictive utility of *specific* types of childhood sleep problems for later psychopathology, bedtime problems and nighttime waking problems were expected to equally predict internalizing problems at age 15.

   <u>Aim 2.</u> The intermediary role of emotional reactivity in accounting for (i.e., mediating) the relation between specific childhood sleep problems and adolescent internalizing problems was examined. Specifically increased emotional reactivity in fifth grade was expected to partially explain the relation between specific sleep problems in third grade and internalizing problems at age 15.

   <u>Aim 3.</u> The impact of sex (moderator) on the relations between specific sleep problems and later internalizing problems was examined. As internalizing problems occur at

higher rates in adolescent females, sex was expected to significantly moderate the direct longitudinal relation between specific sleep problems and later internalizing problems. Additionally, the extent to which emotional reactivity accounted for the association between specific sleep problems and adolescent internalizing problems was expected to depend on sex (i.e., moderated mediation). Specifically, greater risk for adolescent internalizing disorders was expected for females when increased levels of emotional reactivity and sleep problems were present.

Methods

<u>Sample</u>

A total of 1,364 children and their families enrolled in the multi-site, prospective, longitudinal National Institute of Child Health and Development (NICHD) Study of Early Child Care and Youth Development (SECCYD). Broadly, the SECCYD aimed to examine relations among child-care experiences, characteristics, and child developmental outcomes. The original pool of participants was selected in accordance with a continuously random sampling plan. Data was collected on facets of child social, emotional, intellectual and language development, behavioral problems, adjustment problems, and physical health. Information was collected by way of interviews, questionnaires, direct testing, and trained observers. Participants were equally distributed across all 10 geographically diverse sites (7.1%-8.5% of the total sample per site). Participants were assessed annually from birth to age 15, but only data collected during third grade, fifth grade and at age 15 (Phases III & IV) was used in the current study. Demographic information collected at birth was also analyzed.

Of the original sample (N=1,364), 48.3% were female. The sample was racially diverse and was classified as a representative national sample. Of the sample, 80.4% identified the child participant as white, 12.9% as black, 1.6% as Asian or Pacific Islander, and .4% identified the child as American Indian, Eskimo, or Aleutian. A remaining 4.7% identified the child participant as 'other'.

At third grade, 58.8% of children had parents who were married and living together, 9.9% had parents who were either separated or divorced, 4.1% had parents who were partnered and living together, and 4.4% of children had a parent marital relationship

identified as "other". Mean household income at third grade was $77,000.08 (SD= $68,272.663).

Administered at fourth grade, the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) is a short and reliable estimate of general cognitive abilities for ages 6 through 89. WASI scores at fourth grade indicated normative intellectual functioning in the current sample (M=106.75, SD=14.44; Skewness = -.016, SD = .024; Kurtosis = -.132, SD = .049).

Measures

Demographics & Family Employment and Income. Parent report of child sex, race, and ethnicity was collected at birth via a demographic questionnaire. An additional 6-item questionnaire developed for SECCYD was administered to mothers at third grade assessing family income, marital status, and further demographic information.

My Child's Sleep Habits. Collected at third grade, this measure is a set of questions derived from the Children's Sleep Habits Questionnaire (CHSQ; Owens, Spirito, & McGuinn, 2000), a parent report measure of child sleep behaviors, habits, and difficulties with sleep. The original CHSQ (Owens et al., 2000) is a well-validated and highly used measure that assesses a range of child sleep problems (e.g., waking during the night, morning waking, and daytime sleepiness) using a 3-point scale for each item (1 = "usually," 2 = "sometimes," 3 = "rarely," and "don't know"). Items specifically related to bedtime problems and nighttime waking problems (See *Table 2*) were used to create two subscales in the current study. Raw items used to create both scales had modest internal reliability (bedtime problems 6 items, Cronbach's alpha = 0.67; nighttime problems 5 items, Cronbach's alpha = 0.81); modest reliabilities are consistent with previous sleep research and relatively

unsurprising, as Cronbach alpha values are relatively sensitive to the number of items in each scale (e.g., less than 10 items; DeVellis, 2003).

Parent Report of Children's Reactions. Mother report of child emotional reactivity was collected via a 10-item questionnaire administered at fifth grade. The questionnaire was developed for SECCYD to measure maternal perception of child emotional expression in response to events. Example items include 'my child responds very emotionally to stories, movies, and events,' 'when my child feels an emotion, either positive or negative, my child feels it strongly,' and 'my child is slow to become angry, nervous or upset.' Mothers rated the frequency of different observed emotional responses in their children in the context of different events and situations (1=never; 5=always). Reliability of this measure was acceptable (Alpha = .77).

Child Behavior Checklist (Achenbach et al., 1991). Collected at third grade and at age 15, the Child Behavior Checklist (CBCL) is a widely used measure of social competence and problem behavior in children between four to eighteen years of age. Each mother rated approximately 100 different behaviors on a 3-point scale (i.e., 0 = not true; 1=sometimes true; 2=very true). Broad-band scales of Internalizing and Externalizing problems, and narrow band scales of social problems, aggression, attention problems, and depression (among others) were derived from a computerized scoring program. The CBCL is highly reliable and internally consistent (both broad-band and narrow band factors) measure (Achenbach et al., 1991). In the current study, the CBCL was administered across all time points, but only mother-reported CBCL internalizing scores from third grade and age 15 were included in the analyses. Scores from third grade were used to control for baseline levels of

internalizing problems, and scores at age 15 were used as the primary outcome measure in all models.

<u>Analytic Plan</u>

All analyses were conducted using SPSS version 21. After examining that assumptions required by regression were met (i.e., normality, linearity, and homoscedasticity), bivariate correlations among demographic, sleep, emotional reactivity, and internalizing symptom variables were examined.

Aim 1 was examined using a linear regression framework. After assessing bivariate correlations among variables, sleep problems subscales that significantly correlated with internalizing problems at age fifteen were analyzed in two separate models. In SPSS, the *Analyze*, *Regression*, *Linear* command was used for both regression models. In both models, covariates were entered into block 1, and internalizing problems at 15 years was entered as the dependent variable. In the first model, 'bedtime problems' was entered as the independent variable into block 2. In the second model, 'nighttime waking problems' was entered as the independent variable into block 2. Under the statistics tab, *estimates*, *model fit*, and *R square change* output options were selected. Regression coefficients for both models were based on the following regression equations,

$$\text{Bedtime Problems: } Y_B = i_1 + c\ X_1 + e_Y$$

$$\text{Nighttime Waking Problems: } Y_N = i_1 + c\ X_2 + e_Y$$

Where i_1 is equal to the intercept of each regression line, e_Y is errors in the estimation of Y, and c is the regression coefficients for the specific sleep variable examined in each model.

All remaining analyzes were conducted using the PROCESS Macro in SPSS (installed directly into SPSS). PROCESS is a conditional process modeling program

developed by Preacher and Hayes that utilizes an ordinary least squares-based path analytical framework to test for both direct and indirect effects (Hayes, 2013). This procedure was used to examine each regression pathway in mediation, moderation, and moderated mediation models. All relative indirect effects were subjected to follow-up bootstrap analyses with 10,000 samples and a 95-percentile confidence interval estimate (as recommended by Hayes & Matthes, 2009; Preacher & Hayes, 2008). Specific to Aims 2 and 3, tests of indirect effects in PROCESS allowed for assessment of moderation, mediation, and moderated mediation.

To address Aim 2, mediational models were examined for bedtime problems (model 2.1; X_1) and nighttime waking problem (model 2.2; X_2) separately. Emotional reactivity (M) was examined as a mediator of the two regression models described above (Aim 1). Within the PROCESS Macro, "Model 4" (*Figure 1*) was selected to test mediation. Internalizing Problems at age 15 was entered as the outcome variable. Sex, marital status, and income were entered as covariates, and emotional reactivity was entered as the mediator (M) variable. In Model 2.1, bedtime problems was entered as the independent variable, and in Model 2.2, nighttime waking problems was entered as the independent variable. With regards to bootstrapping, 10,000 bias corrected bootstrap samples were requested in PROCESS. Covariates in the model were entered as covariates of both M and Y variables. Both mediation models were based on the following two formulas:

$$M = i_1 + aX_{1-2} + e_M$$

$$Y = i_2 + c'X_{1-2} + bM + e_Y$$

Where i_1 and i_2 are equal to the intercepts of each regression line, e_M and e_Y are errors in the estimation of M and Y, and a, b, and c' are the regression coefficients for each variable in the

model (Hayes, 2013), as represented in *Figure 1*. In this model, X_1 is bedtime problems, X_2 is nighttime waking problems, M is emotional reactivity, and Y is CBCL internalizing score at age 15.

To address Aim 3, sex was first examined as a simple moderator of both regression models (Aim 1). Within the PROCESS Macro, "Model 1" (*Figure 2*) was used to test simple moderation. Internalizing Problems at age 15 was entered as the outcome variable. Marital status and income were entered as covariates, and sex was entered as the moderator (M) variable. In two separate analyses, bedtime problems and nighttime waking problems were entered as the independent variable. Again, 10,000 bias corrected bootstrap samples were requested and covariates in the model were entered as covariates of both M and Y variables. This analysis tested the conditional effect of sex on the link between each specific sleep problem and adolescent internalizing problems based on the following equation:

$$Y = i_1 + b_1X_{1\text{-}2} + b_2MX_{1\text{-}2} + b_3X_{1\text{-}2}M + e_Y$$

Where i_1 is equal to the intercept of the regression line, e_Y is the error in the estimation of M and Y variables, and b_1, b_2, and b_3 are the regression coefficients for each variable in the model. In this model, X_1 is bedtime problems, X_2 is nighttime waking problems, M is sex, and Y is CBCL internalizing scores at age 15.

Also to address Aim 3, the indirect effect of bedtime problem (model 4.1; X_1) and nighttime waking problems (model 4.2; X_2) on adolescent internalizing problems (*Y*) through emotional reactivity (*M*) was examined, with sex (*V/W*) as a moderator. Within the PROCESS Macro, "Model 7" (*Figure 3*) and "Model 14" (*Figure 4*) were used to test moderated mediation. PROCESS Model 7 was used to test *first stage* moderated mediation (Model 4.xa), and PROCESS Model 14 was used to test *second stage* moderated mediation

(Model 4.xb). In *first stage* moderated mediation, the moderator's impact on the link

between the independent variable and the mediator is assessed (i.e., conditional effect of sex

on the link between bedtime/nighttime waking problems and emotional reactivity). In *second*

stage moderated mediation, the moderator's impact on the link between the mediator and the

dependent variable is assessed (i.e., conditional effect of sex on the link between emotional

reactivity and internalizing problems).

When assessing moderated mediation in models 4.1 and 4.2, Internalizing Problems

at age 15 was entered as the outcome variable, marital status and income were entered as

covariates, and emotional reactivity was entered as the mediator (M) variable. Bedtime

problems and nighttime waking problems were each entered individually as the independent

variable in two separate models (Models 4.1 and 4.2, respectively). To test *first stage*

moderated mediation within the Macro, PROCESS "Model 7" was selected, and sex was

entered into the Proposed Moderator W field. To test *second stage* moderated mediation

within the Macro, PROCESS "Model 14" was selected, and sex was entered into the

Proposed Moderator V field. 10,000 bias corrected bootstrap samples were requested across

all moderated mediation analyses and covariates in all models were entered as covariates of

both M and Y variables. Moderated mediation analyses were based on the following two

formulas:

$$M = i_1 + aX_{1\text{-}2} + e_M$$

$$Y = i_2 + c'X_{1\text{-}2} + b_1M + b_2V + b_3MV + e_Y$$

Where i_1 and i_2 are equal to the intercepts of each regression line, e_M and e_Y are errors in the

estimation of *M*, *Y*, and *V*, and *a, b,* and *c'* are the regression coefficients for each variable in

the model (Hayes, 2013). In this model, X_1 is bedtime problems, X_2 is nighttime waking

problems, M is emotional reactivity, V is sex and Y is CBCL internalizing score at age 15.

Results

Linearity for all variables was found to be acceptable based on results of scatter plots

and bivariate correlations. Multicollinearity diagnostics were acceptable, however data were

significantly non-normally distributed. As normality is regarded as the least essential of

assumptions required for linear regression (Hayes, 2013), and as research has demonstrated

that severe normality violations only impact statistical inferences in small samples (e.g.,

Hayes, 1996), transformations to address normality were not conducted.

Missing Data.

Completely Missing/Dropout. Although retention was good throughout the overall

NICHD project, of the original sample, 279 participants had missing data across all sleep,

emotional reactivity, and internalizing measures. When compared to the remaining 1085

participants, individuals with completely missing data were more likely to be male (t=-1.99,

p<.05), to have mothers who were not married and living with the child's father at birth (t=-

3.188, p<.01), and to have mothers who had never been married and were not in a romantic

relationship with the child's father (t=2.28, p<.05). There were no group differences in terms

of race or ethnicity. The 279 individuals with completely missing data were removed from

all analyses, but sex-based differences in cases with and without missing data should be

taken into account when interpreting results.

Missing Individual Measures. Of the remaining 1085 participants, 82 (7.5%) were

missing parent report of bedtime problems, 122 (11.24%) were missing parent report of

nighttime waking problems, and 63(5.8%) were missing mother report of internalizing

problems at third grade. At fifth grade, 64 (5.9%) participants were missing mother report of

emotional reactivity. At 15 years, 112 (10.3%) participants were missing mother report of

internalizing problems. Little's Missing Completely at Random (MCAR) test rejected the

hypothesis that the data are missing completely at random ($\chi^2_{(59)}$= 92.323, p<0.01). The

pattern of missing data is presented in *Table 2*.

Seven groups were created and compared to assess trends in missing data including:

[1] missing nighttime waking problems only; [2] missing internalizing scores at age 15 only;

[3] missing internalizing problems at 3rd grade only; [4] missing internalizing problems at 3rd

grade, bedtime problems and nighttime waking problems; [5] missing bedtime problems and

nighttime waking problems; [6] missing emotional reactivity only; [7] missing emotional

reactivity scores and internalizing problems at 15 years). A MANOVA was completed

comparing the seven missing group classifications. Groups differed on marital status at birth,

but not at third grade. Specifically, participants missing emotional reactivity and

internalizing problems at 15 years were more likely to have parents who were never married

but in a romantic relationship at birth than all other groups (*F*=8.23, *p*<.001). Based on

missing data analyses, marital status at birth (i.e., married and living together family vs. else)

was entered as a covariate in all subsequent analyses. Since data was assumed to be missing

at random, Expectation Maximization imputation was used to account for missing data

(Peugh & Enders, 2004).

Bivariate Correlations

Bivariate Pearson correlations are presented in *Table 3*. Demographic variables were

dummy coded and correlations were examined for white vs. all other racial statuses, married

and living together vs. all other groups at birth, and females vs. males. As expected, females

had significantly higher levels of internalizing problems in adolescence than did males.

When examining race, mothers of children from minority racial groups reported a significantly greater number bedtime problems than did mothers of white children.

A proxy for socioeconomic status, total family income was significantly correlated with marital status and race, suggesting income was greater in white families and in families with intact marriages. Income was significantly negatively correlated with bedtime problems, nighttime waking problems, and internalizing problems at both third grade and age 15, indicating that children from higher SES families experienced fewer bedtime and nighttime waking problems, and fewer internalizing problems across both time points. Based on these results, total family income was included as a covariate in all analyses. Finally, marital status was significantly negatively correlated with bedtime problems, but not with emotional reactivity, nighttime waking problems, or internalizing problems across both time points, suggesting that children whose parents were not married and living together at birth experienced a greater number of bedtime problems at third grade.

Internalizing problems at age 15 (Y) was significantly correlated with bedtime problems (X_1), nighttime waking problems (X_2) emotional reactivity (M), and internalizing problems at third grade. As expected, bedtime problems and nighttime waking problems were significantly positively correlated with each other. Emotional reactivity was also significantly positively correlated with both measures of sleep and both measures of internalizing problems.

<u>Regression Analyses</u>

Linear regression models were examined for bedtime problems (X_1) and nighttime waking problems (X_2) in third grade. Within the SPSS Linear Regression command, sex, marital status, income, and internalizing problems at third grade were entered into block 1 as

covariates, and bedtime problems was entered into block 2 as the independent variable. Internalizing problems at 15 years was entered as the dependent variable. The overall model was significant ($_{adj}R^2= .33$, $df = 5$, 1079, F=107.54, p<0.001) and the inclusion of bedtime problems yielded an increased model significance ($F_{change} = 10.31$, $p < .01$). Parameter estimates demonstrated that bedtime problems was a significant predictor of internalizing problems in adolescence ($t=3.211$, $p<0.01$), as was being female ($t=2.998$, $p<0.01$) and internalizing problems at third grade ($t=21.194$, $p<0.001$).

A second linear regression was examined for nighttime waking problems (X_2). Again, the SPSS Linear Regression command was used and sex, marital status, income, and internalizing problems at third grade were entered into block 1 as covariates. Nighttime waking problems was entered into block 2 as the independent variable and internalizing problems at 15 years was entered as the dependent variable. The overall model was significant ($_{adj}R^2= 0.32$, $df = 5$, 1079, $F = 104.562$, $p < .0001$), yet the inclusion of nighttime waking problems did not increase model significance ($F_{change} = .246$, $p=0.602$). Parameter estimates demonstrated that nighttime waking problems was not a significant predictor of internalizing problems in adolescence ($t=.013$, $p=0.62$). Consistent with the bedtime problems model, female sex ($t=2.88$, $p<0.01$) and internalizing problem in third grade ($t=21.482$, $p<0.001$) were significant predictors of internalizing problems in adolescence. Because nighttime waking problems was not a significant predictor of adolescent internalizing problems, mediation and moderated mediation models including nighttime waking problems were not conducted.

Mediation Analyses

Emotional reactivity in fifth grade was examined as a mediator (M) of the link between bedtime problems (X_1) and adolescent internalizing problems (Y). In model 2.1, (PROCESS "Model 4"; *Figure 1*) mediation was tested using the PROCESS Macro (Hayes, 2013). Internalizing Problems at age 15 was entered as the outcome variable. Sex, marital status, and income were entered as covariates, and emotional reactivity was entered as the mediator (M) variable. Bedtime problems was entered as the independent variable and 10,000 bias corrected bootstrap samples were requested. Covariates in the model were entered as covariates of both M and Y variables. The total direct model was significant ($_{adj}R^2 = .33$, $df = 5$, 1077, F=107.82, p<0.001; path *c*), as was the full model with emotional reactivity included as a mediator ($R^2 = .34$, $df = 6$, 1078, $F = 92.44$, $p < .0001$). The direct effect (*c'* path) of bedtime problems on internalizing problems in adolescence after accounting for covariates and emotional reactivity remained significant per Maximum Likelihood (ML) confidence intervals, $t=2.9720$, $p=.0030$, 95% CI [.3986, 1.9478]. Although path *c'* remained significant, there was a significant indirect effect of bedtime problems on internalizing problems through emotional reactivity (effect *a1*b1*), demonstrated by the bootstrapped 95% CI of the indirect effect, $b=0.097$, $SE = 0.0584$, 95% CI [0.0122, 0.2488]. Results from the conditional process models are presented in *Table 4*.

Moderation Analyses

Sex was first examined as a simple moderator of the relation between bedtime problems in third grade and adolescent internalizing problems (model 3.1). Simple moderation was examined using "Model 1" in PROCESS (*Figure 2*; Hayes, 2013). Marital status, income, and internalizing problems in third grade were entered into the PROCESS

Macro as covariates. Internalizing Problems at age 15 was entered as the outcome variable, sex was entered as the moderator (M) variable, and bedtime problems was entered as the independent variable. 10,000 bias corrected bootstrap samples were requested and covariates in the model were entered as covariates of both M and Y variables. The overall model was significant ($F=89.93$, p<.001), accounting for 33% of the overall variance in adolescent internalizing scores ($R^2=.333$). However the interaction between bedtime problems and sex was not significant (See *Table 4*). That is, sex was not a significant moderator of the link between childhood bedtime problems and adolescent internalizing problems.

Moderated Mediation Analyses

Two models were analyzed to assess the extent to which sex moderated the mediational impact of bedtime problems on internalizing problems through emotional reactivity. To test *first stage* moderated mediation for proposed model 4.1a, PROCESS "Model 7" (*Figure 3*) was analyzed with bedtime problems entered as the independent variable and internalizing problems at age 15 as the outcome variable. Marital status and income were entered as covariates, and emotional reactivity was entered as the mediator (M) variable. Sex was entered into the Proposed Moderator W field and 10,000 bias corrected bootstrap samples were requested. Covariates in the model were entered as covariates of both M and Y variables. The overall model was significant ($R^2= .33$, $df = 5, 1079$, $F = 108.603.01$, $p < .0001$). The direct effect (*c'* path) of bedtime problems on internalizing problems after controlling for emotional reactivity (*M*), sex (*W*) and the interaction of emotional reactivity and sex (*M*W*), remained significant ($t=2.85$, $p=.004$). There was a significant conditional indirect effect of bedtime problems on adolescent internalizing problems through emotional reactivity for males, but not for females (See *Table 4*), yet the

bootstrapped estimates revealed a non-significant moderated mediation effect, b=-.026, SE=.091, 95% CI [-.245, .121]. Thus, the extent to which emotional reactivity accounted for the link between bedtime problems and adolescent internalizing problems was not conditional on sex in the first stage of the model (i.e. a path).

To test *second stage* moderated mediation, PROCESS "Model 14" was selected within the Macro, and sex was entered into the Proposed Moderator V field. Again, bedtime problems entered as the independent variable and internalizing problems at age 15 entered as the outcome variable. The same covariates, mediator and bootstrapping methods were used. The overall model was significant (R^2= .34, df = 7, 1077, F = 50.29, $p < .0001$). The direct effect (c' path) of bedtime problems on internalizing problems after controlling for emotional reactivity (M), sex (V) and the interaction of emotional reactivity and sex ($M*V$), remained significant (t=3.024, p<.05). There was a significant conditional indirect effect of bedtime problems on internalizing problems through emotional reactivity for females only, and the test of moderated mediation was significant, b=.124, SE=.0885, 95% CI [.014, .377]. Specifically, emotional reactivity partially mediated the link between third grade bedtime problems and internalizing problems in adolescence for girls only. The interaction between emotional reactivity and sex is graphically represented in *Figure 5*, demonstrating that females with higher levels of emotional reactivity in fifth grade were significantly more likely to experience internalizing problems at age 15. Moderated mediation model parameters are reported in *Table 4*.

Discussion

The current study revealed several notable findings. First, since previous longitudinal research has primarily relied on broad-based measures of childhood 'sleep problems', we sought to separate this construct into more discrete sleep-related behaviors in order to better understand their individual predictive utility of later internalizing problems. We therefore examined both bedtime problems and night waking problems in third grade among a large, representative sample. Results revealed that just over 20% of the sample experienced at least one bedtime problem, while 5.4% experienced a nighttime waking problem. Although some overlap in the experience of these problems is likely, overall, our findings are consistent with rates of 'sleep problems' reported in other studies of school-aged children (Sadeh et al., 2000).

Sleep problems, generally, are also linked with internalizing problems later in adolescence and adulthood (Gregory et al., 2005; Gregory & O'Connor, 2002). However in the current study, which examined bedtime and nighttime waking problems as separate predictors, only bedtime problems significantly predicted later internalizing problems. Results from this nationally representative sample suggest that problems occurring at bedtime or during the sleep initiation phase are more closely linked with later internalizing problems than are awakenings occurring during the sleep period. This novel finding has potentially meaningful implications for prevention and early intervention efforts among children who present with sleep-related problems, discussed in greater detail below.

It should be noted that the measure of bedtime problems used in the current study included a range of parent-reported behaviors including consistency of bedtime, consistency of sleep onset time, the extent to which the child experienced fear at sleep onset, the sleep

27

environment (i.e., co-sleeping), and associated impairments. Examination of these individual problems may reveal further information about the specific types of problems linked to later internalizing problems. For example, children who co-sleep with parents experience significantly more nighttime fears in comparison to children who sleep alone (Cortesi, Giannotti, Sebastiani, Vagnoni, & Marioni, 2008), with almost 90% of co-sleepers experiencing nighttime fears. Co-sleeping is also associated with less total sleep than is independent sleep (Jenni, Fuhrer, Iglowstein, Molinari, & Largo, 2005). Thus, co-sleeping alone may be connected to later internalizing symptoms through a number of related mechanisms. Future research should therefore use more refined measures of child bedtime problems to elucidate this longitudinal relationship.

Items assessing nighttime waking problems in the current study were also relatively heterogeneous which may in part account for non-significance in predicting adolescent internalizing problems. Specifically, this subscale assessed nightmares, night terrors, frequency of nighttime awakenings, and the interference associated with nighttime awakenings. As compared to infancy and toddlerhood when caregivers are more involved in sleep routines, parents of school-aged children are less likely to be aware of these problems. Additional factors may explain low rates of nighttime waking problems, as well as their non-significant link with later internalizing problems in the current study. Both nightmares and night terrors are normative phenomena in children (*DSM-5*, 2013) and parental report of these problems may only arise when their occurrence is frequent and/or severe (i.e., child calls for or seeks out the parent after a nightmare). Thus, future research should seek to more closely define the nature of children's nighttime awakenings.

<u>Emotional Reactivity as a Mediator</u>

After controlling for sex, SES, and parental marital status, emotional reactivity during fifth grade was found to partially mediate the link between childhood bedtime problems and adolescent internalizing problems. In other words, increased emotional displays in middle childhood partially accounted for the relationship between bedtime problems in third grade and anxiety/depressive symptoms at age 15. These findings coincide with results from experimental research showing sleep deprived (SD) adults to experience increased physiologic reactivity (i.e., pupillary response) in response to negatively valance pictures (Franzen, Buysse, Dahl, Thompson, & Siegle, 2009). In the same study, SD and non-SD individuals were compared on their speed of pupillary response. Reactivity was noted to begin with stimulus onset in the non-SD group, whereas SD individuals began reacting to a pre-stimulus warning cue during negatively valenced trials (Franzen et al., 2009) suggesting that emotional conditioning for negative information may occur more quickly for SD individuals (Franzen et al., 2009).

Research in adolescents reveals similar findings. In a sleep deprivation study examining positive affect, negative affect, and worry/catastrophizing across adults, young adolescents, and older adolescents, SD subjects of all ages experienced decreases in positive affect (Talbot et al., 2010). However, young adolescents endorsed their worries as significantly more threatening than did older adolescents and adults, suggesting that younger teens may be at higher risk for anxiety and other internalizing symptoms when sleep deprived (Talbot et al., 2010). Results from the current longitudinal study are consistent with these findings by showing sleep problems to increases risk for later internalizing behaviors via

negative changes in emotional functioning. Future research is nonetheless needed based on more comprehensive measures of emotional processing.

The impact of the environment on emotional reactivity should also be considered. Early in development, emotional reactivity and regulation begin as physiologically based tendencies (i.e., temperament) that are further regulated by parental behaviors and practices (Calkins & Hill, 2007). Over time, as children aquire greater self-regulatory abilities, the parent becomes less involved in scafolding these skills (Calkins & Hill, 2007). Thus, our findings may in part represent early environmental influences in the forms of parental modeling and shaping of emotional reactivity. Research incorporating assessments of these variables in the early home environment and family unit will be better able elucidate these complex relationships.

Moderated Mediation

Sex was a significant moderator of the indirect effect of bedtime problem on internalizing problems through emotional reactivity with girls evidencing greater levels of risk. Moderated mediation analyses showed this conditional effect was explained within the second stage of the model: the path between emotional reactivity and internalizing problems. In contrast, the pathways from bedtime problems to emotional reactivity and bedtime problems to adolescent internalizing problems did not differ based on sex. Thus, whereas bedtime problems served to predict adolescent internalizing problems for all children, only for girls did increased emotional reactivity during the pre–adolescent years explain (a portion of) this relationship. This finding falls in line with previous sleep deprivation research showing females to possess a greater sensitivity than males to sleep loss in terms of affective responses (Shaffery, Hoffmann, & Armitage, 2003; van der Helm, Gujar, & Walker, 2010).

A greater sensitivity to inadequate sleep is likely to have important implications for the increased prevalence of internalizing problems in females (Blazer, Kessler, McGonagle, & Swartz, 1994).

Further, as emotional reactivity was examined in fifth grade, the effect of pubertal timing may be critical to consider. Girls typically begin to develop earlier than boys (Herman-Giddens, et al., 1997) and the onset of puberty is associated with a shift toward an evening chronotype (i.e., preference for staying up later in the evening and waking later in the morning) (Roenneberg et al., 2004). Evening chronotypes have been found to be at greater risk for both sleep and internalizing disorders than morning types (Selvi et al., 2010). In sleep-deprived adolescents, evening-type individuals experience greater increases in negative affect and decreases in positive affect than do their morning-type peers (Dagys et al., 2012). These data suggest that an evening preference in teens may increase risk for emotional vulnerability in the presence of reduced sleep (Dagys et al., 2012) and that risk may be greatest among adolescent girls.

With regard to findings for emotional reactivity, females are typically more emotionally expressive than males (Rudolph, 2002) and are more emotionally reactive to negative/unpleasant pictures (McManis, Bradley, Berg, Cuthbert, & Lang, 2001). Gender differences in stress reactivity also appear to emerge around puberty, with females showing significantly higher levels of stress reactivity in response to *interpersonal* stress than males (Rudolph, 2002; Rudolph & Hammen, 1999). Not only are females more reactive to interpersonal stress, they are also more likely to experience increased interpersonal stress (Rudolph & Hammen, 1999) in addition to the already elevated stress levels that occur with the onset of adolescence (Ge, Lorenz, Conger, Elder, & Simons, 1994; Larson & Ham,

1993). Increased stress exposure among adolescent females (Rudolph & Hammen, 1999) coupled with intensified responses to interpersonal stress has been linked with both anxiety and depression (Rudolph, 2002). Specifically, this sex difference in reactivity to interpersonal stress has been found to partially account for the increased internalizing disorders in females after the onset of puberty (Rudolph, 2002). Taken together, these results support the findings of the present study, and suggest that early sleep problems may play a critical role in shaping emotional reactivity and increasing risk for internalizing symptoms.

Despite evidence for emotional reactivity to serve as a mediator of the link between childhood bedtime problems and adolescent emotional problems in girls only, problems with emotion regulation are believed to underlie both internalizing and externalizing disorders in youth (Cole, Michel, & O'Donnell-Teti, 1994). Just as females experience greater rates of internalizing problems, externalizing problems are more common in males (Rutter, Caspi & Moffitt 2003). Thus, boys who experience bedtime problems in childhood and increased emotional reactivity during the pre-teen years may be at greater risk for externalizing problems than girls. Future research should therefore examine the differential impact of emotion reactivity/regulation on the development of different forms of psychopathology in boys and girls with problematic sleep behaviors.

Limitations

Despite numerous strengths of the current study, several factors limit the conclusions that can be drawn. Although measures of bedtime problems and nighttime waking problems used in the current study were based on the validated Child Sleep Habits Questionnaire (Owens et al., 2000), the measure used was developed specifically for the NICHD SECCYD study. Although subscales are similar across the original CSHQ and the current version, the

reliability of the SECCYD measure has not been established. Further, assessment of bedtime sleep problems based on objective measures of sleep is ultimately needed to confirm these relationships. Additionally, the persistence of sleep problems was not assessed in the current study and previous research has highlighted the chronicity of child sleep problems to be particularly important in predicting later psychopathology (e.g., Gregory et al., 2005). Overall, future research should include multiple types of sleep measures and multiple assessment points as many sleep problems may be transient.

There are several limitations relating to emotional reactivity measurement within the current study. As previously stated, emotional reactivity is one of the five parts of Gross' process model of emotional regulation (Gross, 1998) and the child with increased levels of emotional reactivity may not be the same child who experiences problems regulating his or her emotions. Thus, inclusion of more comprehensive measure of emotional processing and regulation should be considered in future research. Further, changes in emotional reactivity across time were not assessed in the present study. Although there was temporal precedence to support the mediating effect of emotional reactivity, actual changes in emotional reactivity across development were not examined. As emotional reactivity is a dynamic and developmentally based process reliant upon attentional, behavioral, and cognitive skills (Calkins & Hill, 2007), this reamins an important direction for future research.

To measure internalizing problems, the current study used a validated scale of broadband behavior in children (CBCL; Achenbach et al., 1991), yet mention should be made of the items that comprise this scale. The CBCL internalizing scale is comprised of questions from the anxious/depressed, withdrawn/depressed, and somatic problems syndrome scales. Thus, items may not map directly onto disorders classified as internalizing disorders,

but are part of the broader construct of internalizing problems. Future studies should assess both broad-based internalizing problems as well as the presence of more specific affective symptoms in understanding the impact of specific sleep problems on later internalizing problems.

Lastly, all measures examined in the present study were collected via subjective maternal report. Future research should work to include additional reporters, including child report of sleep, emotion, and internalizing-related problems. Despite these limitations, the current study significantly contributes to the available literature by linking bedtime problems but not nighttime waking problems with adolescent internalizing problems. This finding, in combination with evidence for elevated risk among girls based on increased levels of emotional reactivity in fifth grade underscore the potential for behavioral sleep interventions, as well as interventions targeting internalizing symptoms as avenues for prevention.

Implications and Conclusions

Results from the current study make several important contributions to the existing literature on sleep and psychological problems in childhood. Although a majority of available research implicates broad 'sleep problems' to predict later internalizing problems (Gregory et al., 2005; Gregory et al., 2004; Gregory & O'Connor, 2002; Ong et al., 2006), results from the current study challenge these broad links, and suggest that bedtime problems more specifically may serve to elevate risk. Successful development of effective intervention and prevention techniques indeed requires a clear understanding of predictors and risk factors. Although further research is needed, results of the current study call for increased early intervention and prevention efforts for children with sleep problems broadly, and for girls with bedtime-based sleep problems and high levels of emotional reactivity in middle

childhood in particular. Early parental awareness of bedtime problems should also be targeted through educational campaigns, as many parents may be naïve of the presence and/or potential impact of these early problems. Pediatricians should assess and provide appropriate referrals for sleep related problems in children, including behavioral sleep problems.

References

Achenbach, T. M., Howell, C. T., Quay, H. C., & Conners, C. K. (1991). National survey of problems and competencies among four- to sixteen-year-olds: parents' reports for normative and clinical samples. *Monogr Soc Res Child Dev, 56*(3), 1-131.

Alfano, C. A., Ginsburg, G. S., & Kingery, J. N. (2007). Sleep-related problems among children and adolescents with anxiety disorders. *J Am Acad Child Adolesc Psychiatry, 46*(2), 224-232. doi: 10.1097/01.chi.0000242233.06011.8e

Anders, T., Sadeh, A., & Appareddy, V. (Eds.). (1995). *Normal sleep in neonates and children*. Philadelphia: WB Saunders.

Angold, A., Costello, E. J., & Worthman, C. M. (1998). Puberty and depression: the roles of age, pubertal status and pubertal timing. *Psychol Med, 28*(1), 51-61.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182.

Bechara, A., Damasio, H., Damasio, A. R., & Lee, G. P. (1999). Different contributions of the human amygdala and ventromedial prefrontal cortex to decision-making. *J Neurosci, 19*(13), 5473-5481.

Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (1997). Deciding advantageously before knowing the advantageous strategy. *Science, 275*(5304), 1293-1295.

Bell, B. G., & Belsky, J. (2008). Parents, parenting, and children's sleep problems:Exploring reciprocal effects. *British Journal of Developmental Psychology, 26*, 579–593.

36

Berger, R. H., Miller, A. L., Seifer, R., Cares, S. R., & Lebourgeois, M. K. (2012). Acute
sleep restriction effects on emotion responses in 30- to 36-month-old children
(Vol. 21, pp. 235-246). Journal of Sleep Research.

Blazer, D. G., Kessler, R. C., McGonagle, K. A., & Swartz, M. S. (1994). The prevalence
and distribution of major depression in a national community sample: the
National Comorbidity Survey. *Am J Psychiatry, 151*(7), 979-986.

Breslau, N., Roth, T., Rosenthal, L., & Andreski, P. (1996). Sleep disturbance and
psychiatric disorders: a longitudinal epidemiological study of young adults. *Biol
Psychiatry, 39*(6), 411-418.

Calkins, S. D., & Hill, A. (2007). Caregiver Influences on Emerging Emotion Regulation.
In J. J. Gross (Ed.), *Handbook of Emotion Regulation*. New York, NY: The
Guilford Press.

Campbell, A., Neill, A., & Lory, R. (2012). Ethnicity and socioeconomic status predict
initial continuous positive airway pressure compliance in New Zealand adults
with obstructive sleep apnoea. *Intern Med J, 42*(6), e95-101. doi: 10.1111/j.1445-
5994.2010.02360.x

Carskadon, M. A., Harvey, K., & Dement, W. C. (1981). Sleep loss in young adolescents.
Sleep, 4(3), 299-312.

Casey, B. J., Giedd, J. N., & Thomas, K. M. (2000). Structural and functional brain
development and its relation to cognitive development. *Biological psychology,
54*(1), 241-257.

Cole, P. M., Michel, M. K., & Teti, L. O. (1994). The development of emotion regulation and dysregulation: a clinical perspective. *Monogr Soc Res Child Dev, 59*(2-3), 73-100.

Cortesi, F., Giannotti, F., Sebastiani, T., Vagnoni, C., & Marioni, P. (2008). Cosleeping versus solitary sleeping in children with bedtime problems: child emotional problems and parental distress. *Behav Sleep Med, 6*(2), 89-105. doi: 10.1080/15402000801952922

Cousins, J. C., Whalen, D. J., Dahl, R. E., Forbes, E. E., Olino, T. M., Ryan, N. D., & Silk, J. S. (2011). The bidirectional association between daytime affect and nighttime sleep in youth with anxiety and depression. *J Pediatr Psychol, 36*(9), 969-979. doi: 10.1093/jpepsy/jsr036

Dagys, N., McGlinchey, E. L., Talbot, L. S., Kaplan, K. A., Dahl, R. E., & Harvey, A. G. (2012). Double trouble? The effects of sleep deprivation and chronotype on adolescent affect. *J Child Psychol Psychiatry, 53*(6), 660-667. doi: 10.1111/j.1469-7610.2011.02502.x

Dahl, R. E. (1996). The impact of inadequate sleep on children's daytime cognitive function. *Semin Pediatr Neurol, 3*(1), 44-50.

Derryberry, D., Reed, M. A., & Pilkenton-Taylor, C. (2003). Temperament and coping: advantages of an individual differences perspective. *Dev Psychopathol, 15*(4), 1049-1066.

DeVellis, R. F. (2003). Factor analysis, scale development theory and application. *Appl. Soc. Res. Method Ser, 26*, 10-137.

Dewald, J. F., Meijer, A. M., Oort, F. J., Kerkhof, G. A., & Bögels, S. M. (2010). The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescents: A meta-analytic review. *Sleep Med Rev, 14*(3), 179-189. doi: 10.1016/j.smrv.2009.10.004

Diagnostic and Statistic Manual of Mental Disorders (DSM-5). (2013). Washington, DC: American Psychiatric Association.

Dinges, D. F., Pack, F., Williams, K., Gillen, K. A., Powell, J. W., Ott, G. E., . . . Pack, A. I. (1997). Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4-5 hours per night. *Sleep, 20*(4), 267-277.

Díaz-Morales, J. F., de León, M. C., & Sorroche, M. G. (2007). Validity of the Morningness-Eveningness Scale for Children among Spanish adolescents. *Chronobiol Int, 24*(3), 435-447. doi: 10.1080/07420520701420659

Eisenberg, N., Fabes, R. A., Murphy, B., Maszk, P., Smith, M., & Karbon, M. (1995). The role of emotionality and regulation in children's social functioning: a longitudinal study. *Child Dev, 66*(5), 1360-1384.

Eisenberg, N., Guthrie, I. K., Fabes, R. A., Reiser, M., Murphy, B. C., Holgren, R., . . . Losoya, S. (1997). The relations of regulation and emotionality to resiliency and competent social functioning in elementary school children. *Child Dev, 68*(2), 295-311.

El-Sheikh, M., & Buckhalt, J. A. (2005). Vagal regulation and emotional intensity predict children's sleep problems. *Dev Psychobiol, 46*(4), 307-317. doi: 10.1002/dev.20066

Everson, C. A., Bergmann, B. M., & Rechtschaffen, A. (1989). Sleep deprivation in the

rat: III. Total sleep deprivation. *Sleep, 12*(1), 13-21.

Fine, S. E., Izard, C. E., Mostow, A. J., Trentacosta, C. J., & Ackerman, B. P. (2003).

First grade emotion knowledge as a predictor of fifth grade self-reported

internalizing behaviors in children from economically disadvantaged families.

Dev Psychopathol, 15(2), 331-342.

Ford, D. E., & Kamerow, D. B. (1989). Epidemiologic study of sleep disturbances and

psychiatric disorders. An opportunity for prevention? *JAMA, 262*(11), 1479-1484.

Franzen, P. L., Buysse, D. J., Dahl, R. E., Thompson, W., & Siegle, G. J. (2009). Sleep

deprivation alters pupillary reactivity to emotional stimuli in healthy young

adults. *Biol Psychol, 80*(3), 300-305. doi: 10.1016/j.biopsycho.2008.10.010

Fredriksen, K., Rhodes, J., Reddy, R., & Way, N. (2004). Sleepless in Chicago: tracking

the effects of adolescent sleep loss during the middle school years. *Child Dev,

75*(1), 84-95.

Fuligni, A. J., & Hardway, C. (2006). Daily Variation in Adolescents' Sleep, Activities,

and Psychological Well-Being (Vol. 16, pp. 353-378). Journal of Research on

Adolescence: Society for Research on Adolescence.

Ge, X., Lorenz, F. O., Conger, R. D., Elder, G. H., & Simons, R. L. (1994). Trajectories

of stressful life events and depressive symptoms during adolescence.

Developmental Psychology, 30(4), 467-483.

Gregory, A. M., Caspi, A., Eley, T. C., Moffitt, T. E., Oconnor, T. G., & Poulton, R.

(2005). Prospective longitudinal associations between persistent sleep problems in

40

childhood and anxiety and depression disorders in adulthood. *J Abnorm Child Psychol, 33*(2), 157-163.

Gregory, A. M., Caspi, A., Moffitt, T. E., & Poulton, R. (2009). Sleep problems in childhood predict neuropsychological functioning in adolescence. *Pediatrics, 123*(4), 1171-1176. doi: 10.1542/peds.2008-0825

Gregory, A. M., Eley, T. C., O'Connor, T. G., & Plomin, R. (2004). Etiologies of associations between childhood sleep and behavioral problems in a large twin sample. *J Am Acad Child Adolesc Psychiatry, 43*(6), 744-751. doi: 10.1097/01.chi/0000122798.47863.a5

Gregory, A. M., & O'Connor, T. G. (2002). Sleep problems in childhood: a longitudinal study of developmental change and association with behavioral problems. *J Am Acad Child Adolesc Psychiatry, 41*(8), 964-971. doi: 10.1097/00004583-200208000-00015

Gross, J. J. (1998). The Emerging Field of Emotion Regulation: An Integrative Review (Vol. 2, pp. 271-299). Review of General Psychology: Educational Publishing Foundation.

Hankin, B. L., Abramson, L. Y., Moffitt, T. E., Silva, P. A., McGee, R., & Angell, K. E. (1998). Development of depression from preadolescence to young adulthood: emerging gender differences in a 10-year longitudinal study. *J Abnorm Psychol, 107*(1), 128-140.

Hayes, A. F. (1996). Permutation Test Is Not Distribution-Free: Testing HQ: p = 0 *Psychological Methods, 1*(2), 184-198.

Hayes, A. F. (2013). Introduction to mediation, moderation, and conditional process analysis. New York, NY: Guilford.

Hayes, A. F., & Matthes, J. (2009). Computational procedures for probing interactions in OLS and logistic regression: SPSS and SAS implementations. *Behav Res Methods, 41*(3), 924-936. doi: 10.3758/BRM.41.3.924

Herman-Giddens, M. E., Slora, E. J., Wasserman, R. C., Bourdony, C. J., Bhapkar, M. V., Koch, G. G., & Hasemeier, C. M. (1997). Secondary sexual characteristics and menses in young girls seen in office practice: a study from the Pediatric Research in Office Settings network. *Pediatrics, 99*(4), 505-512.

Jenni, O. G., Fuhrer, H. Z., Iglowstein, I., Molinari, L., & Largo, R. H. (2005). A longitudinal study of bed sharing and sleep problems among Swiss children in the first 10 years of life. *Pediatrics, 115*(1 Suppl), 233-240. doi: 10.1542/peds.2004-0815E

Joormann, J., Talbot, L., & Gotlib, I. H. (2007). Biased processing of emotional information in girls at risk for depression. *J Abnorm Psychol, 116*(1), 135-143. doi: 10.1037/0021-843X.116.1.135

Kahn, A., Van de Merckt, C., Rebuffat, E., Mozin, M. J., Sottiaux, M., Blum, D., & Hennart, P. (1989). Sleep problems in healthy preadolescents. *Pediatrics, 84*(3), 542-546.

Knutson, K. L. (2005). The association between pubertal status and sleep duration and quality among a nationally representative sample of U. S. adolescents. *Am J Hum Biol, 17*(4), 418-424. doi: 10.1002/ajhb.20405

Kraemer, H. C., Kiernan, M., Essex, M., & Kupfer, D. J. (2008). How and why criteria

    defining moderators and mediators differ between the Baron & Kenny and

    MacArthur approaches. *Health Psychol, 27*(2 Suppl), S101-108. doi:

    10.1037/0278-6133.27.2(Suppl.).S101

Larson, R., & Ham, M. (1993). Stress and "storm and stress" in early adolescence: the

    relationship of negative events with dysphoric affect. *Developmental Psychology,*

    29(1), 130-140.

Lauderdale, D. S., Knutson, K. L., Yan, L. L., Rathouz, P. J., Hulley, S. B., Sidney, S., &

    Liu, K. (2006). Objectively measured sleep characteristics among early-middle-

    aged adults: the CARDIA study. *Am J Epidemiol, 164*(1), 5-16. doi:

    10.1093/aje/kwj199

Lerner, R. L., Palermo, M., Spiro, A., & Nesselroade, J. R. (1982). Assessing the

    dimensions of temperament individually across the life-span: The Dimensions of

    Temperament Surveys (DOTS). *Child Development, 53*, 149-159.

Liu, X., Buysse, D. J., Gentzler, A. L., Kiss, E., Mayer, L., Kapornai, K., . . . Kovacs, M.

    (2007). Insomnia and hypersomnia associated with depressive phenomenology

    and comorbidity in childhood depression. *Sleep, 30*(1), 83-90.

MacKinnon, D. P. (2008). *Introduction to Statistical Mediation Analysis*. New York, NY:

    Taylor & Francis Group, LLC.

McManis, M. H., Bradley, M. M., Berg, W. K., Cuthbert, B. N., & Lang, P. J. (2001).

    Emotional reactions in children: verbal, physiological, and behavioral responses

    to affective pictures. *Psychophysiology, 38*(2), 222-231.

Mezulis, A. H., Priess, H. A., & Hyde, J. S. (2011). Rumination Mediates the
Relationship between Infant Temperament and Adolescent Depressive Symptoms.
Depress Res Treat, 2011, 487873. doi: 10.1155/2011/487873

Mindell, J. A. (1993). Sleep disorders in children. *Health Psychol, 12*(2), 151-162.

Montgomery-Downs, H. E., O'Brien, L. M., Gulliver, T. E., & Gozal, D. (2006).
Polysomnographic characteristics in normal preschool and early school-aged
children. *Pediatrics, 117*(3), 741-753. doi: 10.1542/peds.2005-1067

Ong, S. H., Wickramaratne, P., Tang, M., & Weissman, M. M. (2006). Early childhood
sleep and eating problems as predictors of adolescent and adult mood and anxiety
disorders. *J Affect Disord, 96*(1-2), 1-8. doi: 10.1016/j.jad.2006.05.025

Owens, J. A., Spirito, A., & McGuinn, M. (2000). The Children's Sleep Habits
Questionnaire (CSHQ): psychometric properties of a survey instrument for
school-aged children. *Sleep, 23*(8), 1043-1051.

Pesonen, A. K., Räikkönen, K., Paavonen, E. J., Heinonen, K., Komsi, N., Lahti, J., . . .
Strandberg, T. (2010). Sleep duration and regularity are associated with
behavioral problems in 8-year-old children. *Int J Behav Med, 17*(4), 298-305. doi:
10.1007/s12529-009-9065-1

Peugh, J. L., & Enders, C. K. (2004). Missing data in educational research: a review of
reporting practices and suggestions for improvement. *Review of Educational
Research, 74*(4), 525-556.

Pilcher, J. J., & Huffcutt, A. I. (1996). Effects of sleep deprivation on performance: a
meta-analysis. *Sleep, 19*(4), 318-326.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for

assessing and comparing indirect effects in multiple mediator models. *Behav Res*

Methods, 40(3), 879-891.

Riemann, D., & Voderholzer, U. (2003). Primary insomnia: a risk factor to develop

depression? *J Affect Disord, 76*(1-3), 255-259.

Roenneberg, T., Kuehnle, T., Pramstaller, P. P., Ricken, J., Havel, M., Guth, A., &

Merrow, M. (2004). A marker for the end of adolescence. *Curr Biol, 14*(24),

R1038-1039. doi: 10.1016/j.cub.2004.11.039

Rudolph, K. D. (2002). Gender differences in emotional responses to interpersonal stress

during adolescence. *J Adolesc Health, 30*(4 Suppl), 3-13.

Rudolph, K. D., & Hammen, C. (1999). Age and gender as determinants of stress

exposure, generation, and reactions in youngsters: a transactional perspective.

Child Dev, 70(3), 660-677.

Rutter, M., Caspi, A., & Moffit, T.E. (2003). Using sex differences in psychopathology to

study causal mechanisms: unifying issues and research strategies. *Journal of*

Child Psychology and Psychiatry, 44(8), 1092-1115.

Sadeh, A., & Gruber, R. (1998). Sleep disorders. *Comprehensive clinical psychology, 5*,

629-653.

Sadeh, A., Raviv, A., & Gruber, R. (2000). Sleep patterns and sleep disruptions in

school-age children. *Dev Psychol, 36*(3), 291-301.

Selvi, Y., Aydin, A., Boysan, M., Atli, A., Agargun, M. Y., & Besiroglu, L. (2010).

Associations between chronotype, sleep quality, suicidality, and depressive

symptoms in patients with major depression and healthy controls. *Chronobiol Int, 27*(9-10), 1813-1828. doi: 10.3109/07420528.2010.516380

Sethi, A., Mischel, W., Aber, J. L., Shoda, Y., & Rodriguez, M. L. (2000). The role of strategic attention deployment in development of self-regulation: predicting preschoolers' delay of gratification from mother-toddler interactions. *Dev Psychol, 36*(6), 767-777.

Shaffery, J., Hoffmann, R., & Armitage, R. (2003). The neurobiology of depression: perspectives from animal and human sleep studies. *Neuroscientist, 9*(1), 82-98.

Silk, J. S., Steinberg, L., & Morris, A. S. (2003). Adolescents' emotion regulation in daily life: links to depressive symptoms and problem behavior. *Child Dev, 74*(6), 1869-1880.

Simard, V., Nielsen, T. A., Tremblay, R. E., Boivin, M., & Montplaisir, J. Y. (2008). Longitudinal study of preschool sleep disturbance: the predictive role of maladaptive parental behaviors, early sleep problems, and child/mother psychological factors. *Arch Pediatr Adolesc Med, 162*(4), 360-367. doi: 10.1001/archpedi.162.4.360

Sroufe, L. A. (2000). Early relationships and the development of children. *Infant Mental Health Journal, 21*(1-2), 67-74.

Suveg, C., & Zeman, J. (2004). Emotion regulation in children with anxiety disorders. *J Clin Child Adolesc Psychol, 33*(4), 750-759. doi: 10.1207/s15374424jccp3304_10

Talbot, L. S., McGlinchey, E. L., Kaplan, K. A., Dahl, R. E., & Harvey, A. G. (2010). Sleep deprivation in adolescents and adults: changes in affect. *Emotion, 10*(6), 831-841. doi: 10.1037/a0020138

Tonetti, L., Fabbri, M., & Natale, V. (2008). Sex difference in sleep-time preference and

      sleep need: a cross-sectional survey among Italian pre-adolescents, adolescents,

      and adults. *Chronobiol Int, 25*(5), 745-759. doi: 10.1080/07420520802394191

van der Helm, E., Gujar, N., & Walker, M. P. (2010). Sleep deprivation impairs the

      accurate recognition of human emotions. *Sleep, 33*(3), 335-342.

Wechsler, D. (1999). *Wechsler abbreviated scale of intelligence*: Psychological

      Corporation.

Werner, H., Lebourgeois, M. K., Geiger, A., & Jenni, O. G. (2009). Assessment of

      chronotype in four- to eleven-year-old children: reliability and validity of the

      Children's Chronotype Questionnaire (CCTQ). *Chronobiol Int, 26*(5), 992-1014.

      doi: 10.1080/07420520903044505

Yang, C. K., Kim, J. K., Patel, S. R., & Lee, J. H. (2005). Age-related changes in

      sleep/wake patterns among Korean teenagers. *Pediatrics, 115*(1 Suppl), 250-256.

      doi: 10.1542/peds.2004-0815G

Yoo, S. S., Gujar, N., Hu, P., Jolesz, F. A., & Walker, M. P. (2007). The human

      emotional brain without sleep--a prefrontal amygdala disconnect. *Curr Biol,*

      17(20), R877-878. doi: 10.1016/j.cub.2007.08.007

Zhang, B., & Wing, Y. K. (2006). Sex differences in insomnia: a meta-analysis. *Sleep,*

      29(1), 85-93.

Table 1. Sleep Questionnaire Items by Problem Type and Response Rates

Bedtime Problems	Usually %(n)	Sometime %(n)	Rarely %(n)
1 My child goes to bed at the same time every night*	77.8 (844)	18.2 (198)	**4 (43)**
2 Child falls asleep within to minutes of going to bed*	73.5 (789)	18.9 (205)	**7.6(82)**
3 My child falls asleep in own bed*	84.6 (918)	8.9(97)	**6.5(70)**
4 Child needs me/parent in room to fall asleep	**12.1(131)**	9.3(101)	78.6(853)
5 My child is afraid of sleeping alone	**12.6(137)**	13.1(142)	74.3(806)
6 Getting my child to bed at night is a problem	**9.8 (106)**	24.3(264)	65.9(715)
Nighttime Waking Problems	**Usually**	**Sometime**	**Rarely**
1 Child awakens at night screaming/sweating/inconsolable	**6.9(75)**	1.4(15)	91.7(995)
2 My child awakens alarmed by a frightening dream	**7.4(80)**	10(108)	82.7(897)
3 My child awakes once during the night	**13.1(142)**	17.6(191)	69.3 (752)
4 My child awakes more than once during the night	**10.5(114)**	3.1(34)	86.4(937)
5 How much of a problem are sleep wakings for you	**1.5(16)**	5.4(59)	93.1(1010)

*Note. Bolded items represent responses scored as significant sleep problem ; *Reverse coded items*

Table 2. Missing Data Pattern

# of Cases	Missing Patterns					Complete Data Excluding X
	Internalizing at 3rd	Bedtime Problems	Nighttime Waking Problems	Emotional Reactivity at 5th	Internalizing at 15 years	
815						815
46			X			861
65					X	880
12	X					827
21	X	X	X			937
30		X	X			900
20				X		835
23				X	X	923

NOTE. Patterns with less than 1% cases (11 or fewer) are not displayed; Variables are sorted on missing patterns;

Table 3. Bivariate Correlations

	1	2	3	4	5	6	7	8	9
1. Sex (Female)	1								
2. Race (White)	-0.003	1							
3. Marital Status	0.003	.413**	1						
4. Income at 3rd Grade	0.004	.161**	.295**	1					
5. Bedtime Problems (X_1)	-0.026	-.097**	-.122**	-.104**	1				
6. Nighttime waking Problem (X_2)	-0.015	-0.054	-.081**	-.060*	.329**	1			
7. Emotional Reactivity (*M*)	0.056	0.014	-0.026	-.079**	.116**	.135**	1		
8. Internalizing Third Grade	0.044	-0.013	-.096**	-.126**	.209**	.230**	.219**	1	
9. Internalizing – 15 yrs (*Y*)	.096**	0.031	-.061*	-.096**	.195**	.141**	.216**	.566**	1

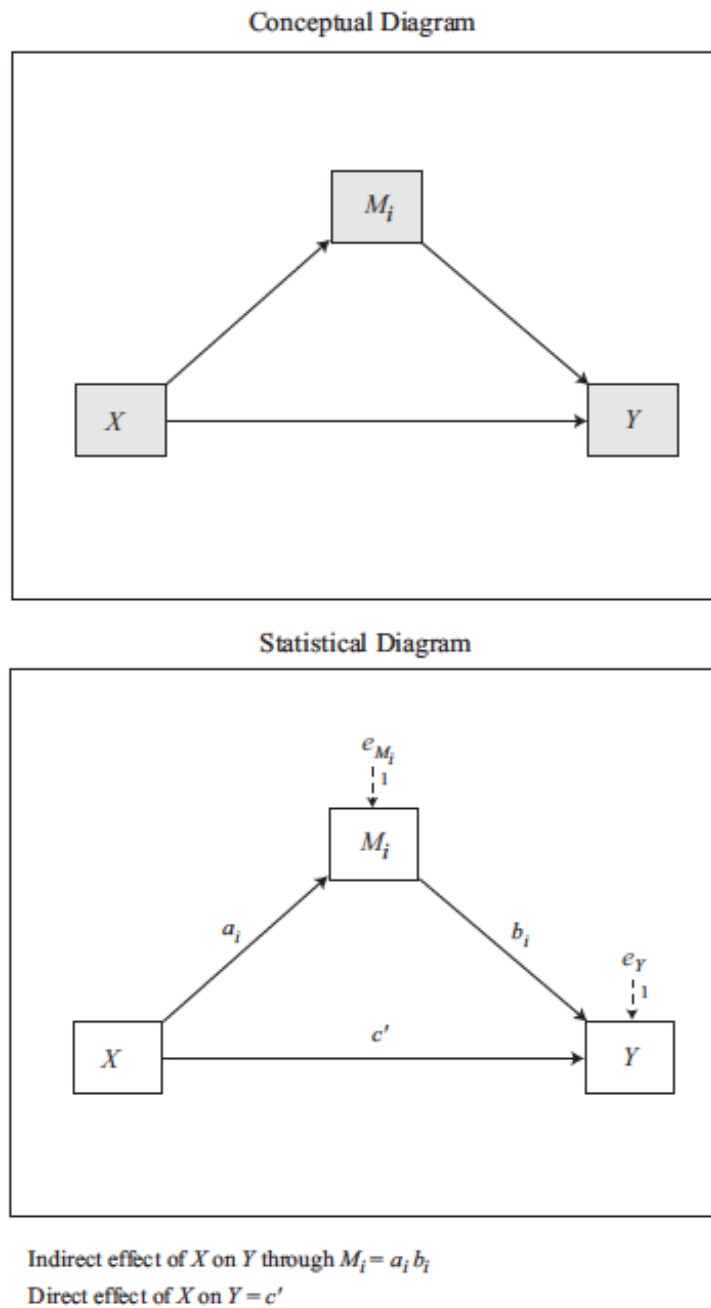*Note. $^t p <0.06$; *p<.05; ** p<.01; Sex – dummy coded, female; Marital status- dummy coded, married and living together; Race – dummy coded, white vs. all else.*

Table 4. Meditation, Moderation, and Moderated Mediation Model Results

| Model 2.1	b	SE	t	p	CI(lower)	CI(Upper)
X_1-->M (a)	1.2128	.5090	2.3826	.0174**	.2140	2.2116
M-->Y (b)	.0802	.0235	3.4041	.0007**	.0340	.1264
X_1-->Y (c)	1.201	0.396	3.032	0.002*	0.424	1.979
X_1-->Y (c')	1.1732	.3948	2.9720	.0030**	.3986	1.9478
X_1-->M-->Y (a1*b1)	.0972	.0584			**.0122**	**.2534***
Model 3.1	**b**	**SE**	**t**	**p**	**CI(lower)**	**CI(Upper)**
X_1-->Y	1.6682	.5072	3.2892	.0010**	.6730	2.6633
V --> Y	2.0144	1.0336	1.9488	.0516	-.0138	4.0426
X_1*V-->Y	-.9790	.7813	-1.2530	.2105	-2.5121	.5541
Conditional Effect for Males	1.6682	.5078	3.1519	.0017**	.6042	2.5969
Conditional Effect for Females	.6892	. 6097	1.1304	.2586	-.5071	1.8854
Model 4.1a (*1st Stage*)	**b**	**SE**	**t**	**p**	**CI(lower)**	**CI(Upper)**
X_1--> M (a)	1.3418	.6529	2.0551	.0401*	.0607	2.6230
M--> Y (b)	.0835	.0236	3.5408	.0004**	.0372	.1298
X_1-->Y (c')	1.1292	.3958	2.8534	.0044**	.3527	1.9058
X_1*W-->M	-.3177	1.0059	-.3158	.7522	-2.2914	1.6560
Conditional Mediation for Males	.1121	.0692			**.0070**	**.2963***
Conditional Mediation for Females	.0856	.0756			-.0422	.2754
Index of Moderated Mediation	-.0265	.0914			-.2453	.1209
Model 4.1b (*2nd Stage*)	**b**	**SE**	**t**	**p**	**CI(lower)**	**CI(Upper)**
X_1--> M (a)	1.1824	.5091	2.3225	.0204*	.1835	2.1814
M--> Y (b)	.0284	.0326	.8722	.3833	-.0355	.0924
X_1-->Y (c')	1.1920	.3941	3.0248	.0025**	.4188	1.9653
M*V-->Y	.1048	.0457	2.2897	.0222*	.0150	.1945
Conditional Mediation for Males	.0336	.0459			-.0292	.1638
Conditional Mediation for Females	.1575	.0877			**.0346**	**.3858***
Index of Moderated Mediation	.1239	.0885			**.0144**	**.3771***

*NOTE: For all models, covariates included marital status, total family income at third grade, and internalizing problems at third grade; for model 3.1, sex was included as a covariate as well; X_1 = Bedtime Problems, M=Emotional Reactivity [mediator], Y= Internalizing at fifteen yrs, W/V=Sex [moderator]; * p < 0.05; ** p < 0.01*

Figure 1. Model 2.1: Indirect Effects of Bedtime Problems on Internalizing Problems

Through Emotional Reactivity

Conceptual Diagram

M_i

X

Y

Statistical Diagram

e_{M_i}

1

M_i

a_i

b_i

e_Y

1

c'

X

Y

Indirect effect of X on Y through $M_i = a_i\, b_i$

Direct effect of X on $Y = c'$

Note: X= Bedtime Problems, M_i=Emotional Reactivity, Y= CBCL Internalizing at fifteen yrs

Figure 2. Model 3.1: Conditional Effects of Bedtime Problems on Adolescent

Internalizing problems Moderated by Sex

Conceptual Diagram

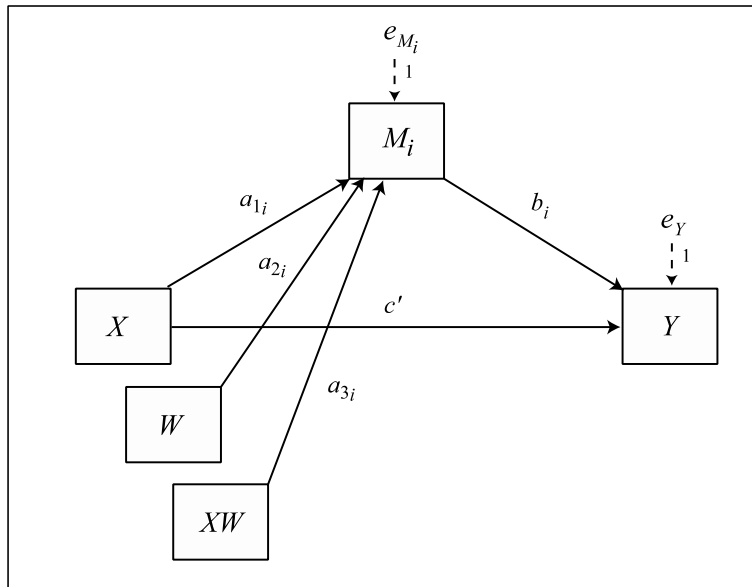Statistical Diagram
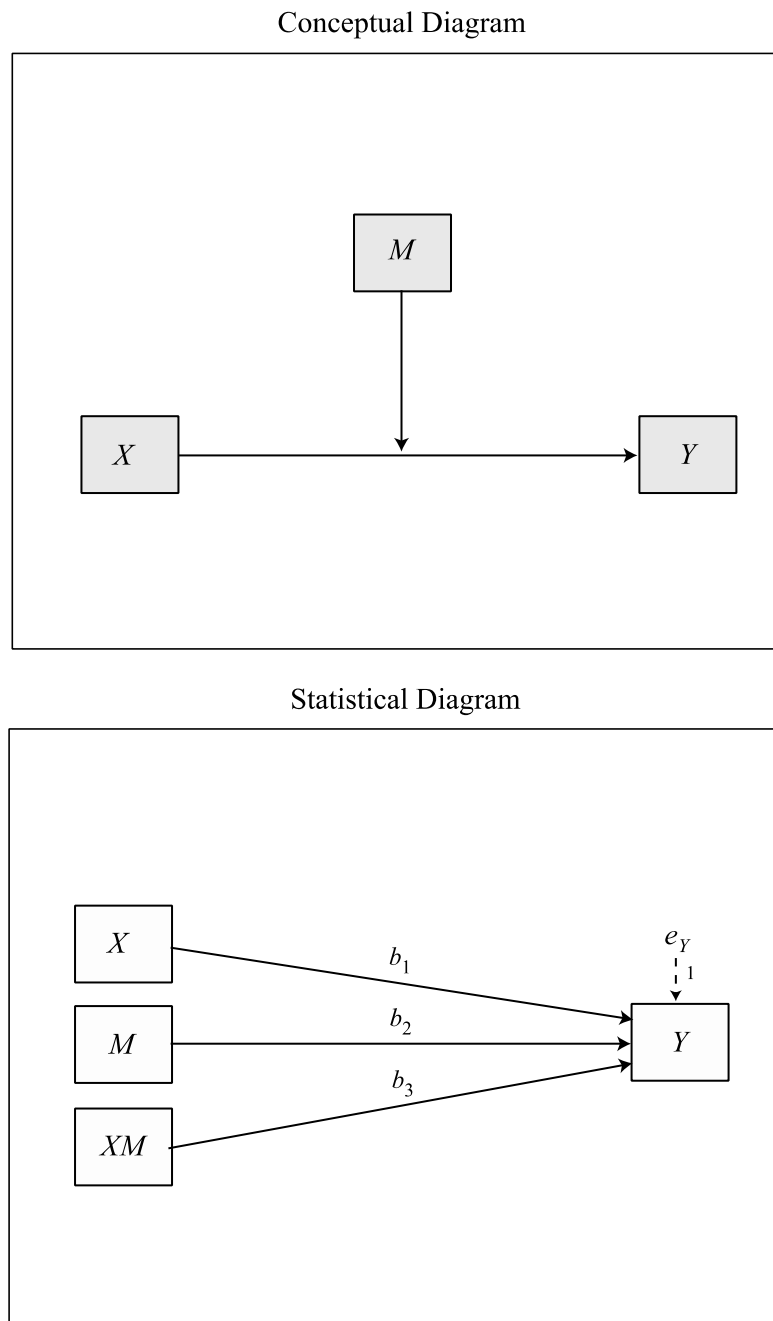
Conditional effect of *X* on $Y = b_1 + b_3M$

Note: X= Bedtime Problems, M_i=Sex(i.e. Female), Y= CBCL Internalizing at fifteen yrs

Figure 3. Model 4.1a Indirect Effects of Bedtime Problems on Internalizing Problems

Through Emotional Reactivity with Sex as a First Stage Moderator
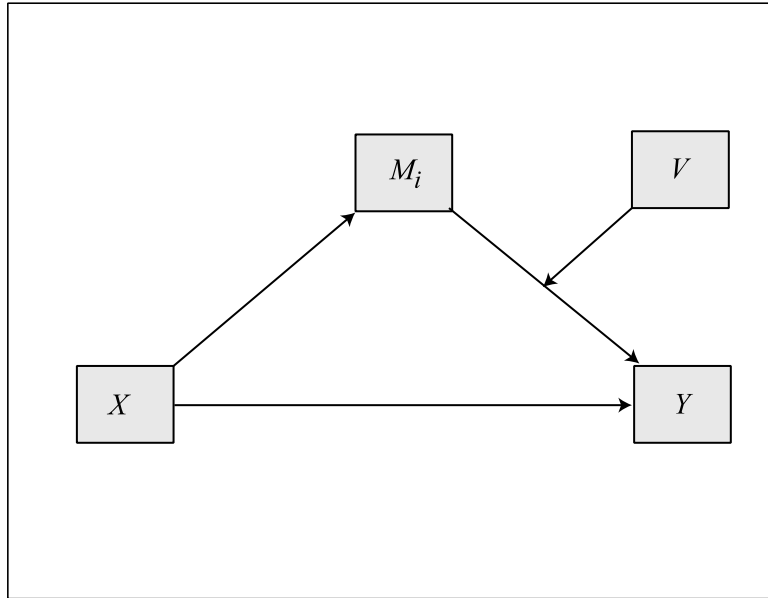
Conceptual Diagram
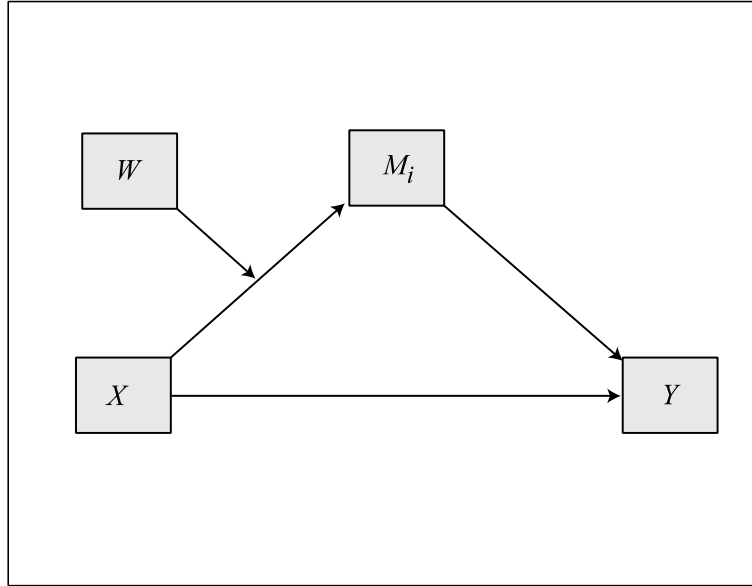
Statistical Diagram

Conditional indirect effect of X on Y through $M_i = (a_{1i} + a_{3i}W)b_i$
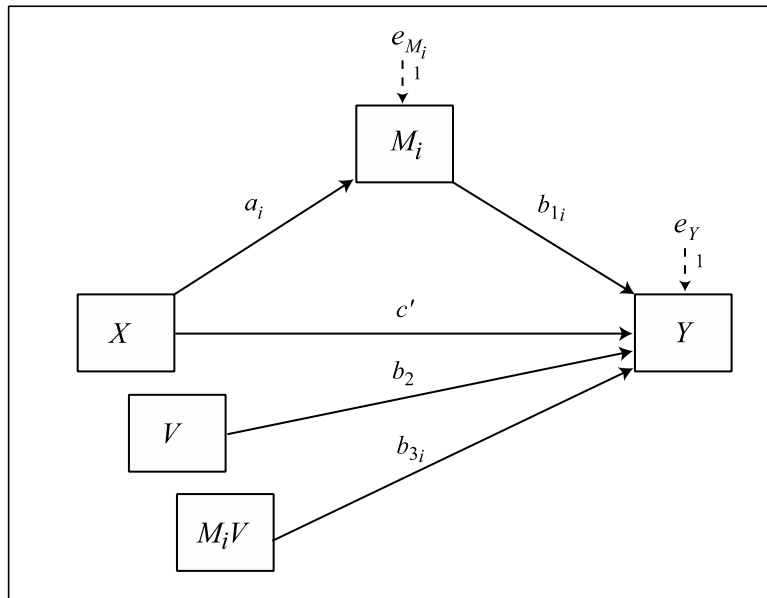
Direct effect of X on $Y = c'$

Note: X= Bedtime Problems, M_i=Emotional Reactivity, Y= CBCL Internalizing at fifteen yrs, W= Sex (Female), X_iW = Interaction of Sex and Bedtime Problems

Figure 4. Model 4.1b: Indirect Effects of Bedtime Problems on Internalizing

Problems Through Emotional Reactivity with Sex as a Second Stage Moderator

Conceptual Diagram

Statistical Diagram

Conditional indirect effect of X on Y through M_i = $a_i (b_{1i} + b_{3i}V)$

Direct effect of X on Y = c'

Note: X= Bedtime Problems, M_i=Emotional Reactivity, Y= CBCL Internalizing at fifteen yrs, V= Sex (male v. female), M_iV = Interaction of Sex and Emotional Reactivity

Figure 5. Interaction Between Sex and Emotional Reactivity Predicting Adolescent Internalizing Problems