

IMPACT OF SLEEP RESTRICTION VERSUS IDEALIZED SLEEP ON AFFECT
AND EMOTION REGULATION IN HEALTHY ADOLESCENTS

A Dissertation

Presented to

The Faculty of the Department

of Psychology

University of Houston

In Partial Fulfillment

Of the Requirements for the Degree of

Doctor of Philosophy

By

Radhika M. Reddy

August, 2014

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ABSTRACT

This study seeks to replicate and expand evidence for the adverse effects of sleep loss on affect and emotion regulation (Pilcher & Huffcut, 1996; Talbot, McGlinchey, Kaplan, Dahl, & Harvey, 2010; Carskadon, 1990; Baum et al., 2014) among a sample of healthy adolescents. Forty two healthy adolescents between the ages of 13 and 17 were randomized to one of two overnight sleep conditions: (1) partial sleep restriction (4 hours total sleep) or (2) idealized sleep (9.5 hours total sleep). The next day, in comparison to participants in the idealized sleep group, adolescents in the restricted sleep group reported lower positive affect on the PANAS-C, and higher state and trait anxiety on the STAIC. There were no significant group differences in reported negative affect on the PANAS-C. Participants also viewed a variety of emotionally-evocative images from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005) and provided affective ratings. No group differences in valence or arousal ratings for any picture type (positive, neutral, or negative) were found. Participants were instructed to utilize a cognitive reappraisal technique to re-evaluate negative IAPS pictures. There were no significant differences between the groups in terms of reappraisal ability (ability to generate cognitive reappraisal statements) or in reappraisal efficacy (efficacy in down-regulating negative emotions through this method), although both groups evidenced reappraisal efficacy. In other words, cognitive reappraisal was equally successful in both groups. Additionally, cognitive reappraisal ability and efficacy were not found to mediate the effects of sleep condition on affect. These findings overall add to a small body of literature showing the adverse effects of sleep restriction on affective functioning among healthy adolescents.

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Introduction

Although there has been a considerable amount of research examining the effects of sleep deprivation on cognitive and motor function, relatively little research has focused on affective functioning. One meta-analytic study nonetheless found that the negative effects of sleep deprivation on mood are stronger than for cognitive or motor performance (Pilcher & Huffcut, 1996). Research documenting such effects has steadily increased in recent years (Walker, 2009; Talbot et al., 2010; Carskadon, 1990; Zohar, Tzischinsky, Epstein, & Lavie, 2005; Vardar et al., 2007, Baum et al., 2014) and it is now well-known that inadequate or disrupted sleep serves as a unique risk factor for the development of a range of psychiatric illnesses across the life span (Ford & Kamerow, 1989; Alfano & Gamble, 2009; Gregory et al., 2005).

Data from a number of longitudinal studies also show persistent sleep problems during the childhood years forecast the development of affective problems and disorders in adolescence (Gregory & O'Connor, 2002) and adulthood (Gregory et al., 2005). Among adults, sleep problems are a risk factor for developing new major depressive episodes the following year (Ford & Cooper-Patrick, 2001). Among elderly women, insomnia predicts depressed mood up to one year later (Mallon, Broman, & Hetta, 2000). Collectively, these studies suggest that sleep disturbance creates robust risk for developing affective problems across the lifespan. Alterations in emotional processing as a result of sleep loss have been hypothesized to underlie linkages between sleep and affective disturbances, however specific mechanisms remain relatively unexplored.

Experimental Sleep Deprivation and Subjective Emotional Responses

A number of studies have documented the effects of experimental sleep deprivation on affect among adults using subjective measures. For example, among a sample of young adults (mean age=22.9 years), Dinges et al. (1997) found that one week of partial sleep restriction (5 hours/night) resulted in progressive increases in tension-anxiety, confusion-bewilderment, and mood disturbance. Franzen, Siegle, and Buysse (2008) found that a night of total sleep deprivation resulted in decreased positive affect, while they found mixed results on its effect on negative affect. Other studies have examined subjective ratings of emotional valence (e.g., negative, neutral, positive) and arousal in response to affective picture stimuli (using the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005) following periods of acute sleep deprivation. However, available findings are relatively inconsistent. In one study participants assigned to a sleep deprivation condition rated the valence of neutral images more negatively than did a rested group (Tempesta et al., 2010), whereas results from another study showed more positively-valenced ratings of affective images following sleep deprivation (Gujar, Yoo, Hu, & Walker, 2011). Most studies have not found differences in self-reported arousal ratings following sleep manipulation.

Pallesen and colleagues (2004) examined the processing of emotional stimuli among 36 sleep-deprived and non-sleep deprived adults and found that accuracy in recognizing emotional facial expressions was compromised in the sleep-deprived group. Response latencies also increased relative to the non-sleep deprived group, suggesting that inadequate sleep compromises emotional processing in terms of both content and timing. In a study by van der Helm, Gujar, and Walker (2010), young adults, ages 18-25,

assigned to a sleep deprivation condition showed decreased accuracy in recognizing others' emotional expressions, especially those in the moderate (i.e., ambiguous) intensity range. This finding was more pronounced in females, suggesting that females may have a heightened vulnerability to the effects of sleep deprivation (van der Helm et al., 2010).

Experimental Sleep Deprivation and Objective Measures of Emotion

Objective findings also provide evidence of a link between sleep deprivation and impaired affective functioning. Yoo, Gujar, Hu, Jolesz, and Walker (2007), for example, compared adult participants who were sleep deprived for one night (35 hours total) to participants who slept normally (control group). The authors found that, relative to participants in the control (rested) condition, participants who were sleep deprived evidenced a 60 percent greater magnitude in amygdala activation in response to negative picture stimuli. Relative to the control group, there was also a three-fold increase in the extent of amygdala volume that was stimulated in response to the negative stimuli in the sleep deprivation group. Additionally, Yoo et al. (2007) found that this greater magnitude of amygdala activity was associated with a failure of top-down control by the prefrontal lobe, as suggested by a significant loss of functional connectivity between the amygdala and the medial prefrontal cortex (mPFC). Overall, findings suggest both greater affective reactivity as well as reduced inhibitory control of the mPFC as a result of sleep deprivation.

Objective evidence of increased emotional reactivity following sleep loss also is provided by a study by Franzen, Buysse, Dahl, Thompson, and Siegle (2009). Specifically, compared to rested healthy young adult participants, sleep-deprived participants demonstrated increased reactions to negative stimuli as evidenced by

significantly increased pupil diameter (an indicator of affective information processing) after viewing the negative pictures as compared to neutral or positive pictures (Franzen et al., 2009). This suggests that sleep deprivation can cause increased reactions to negative emotional stimuli. Of note, Franzen and colleagues (2009) did not find group differences in subjective ratings for images.

Experimental Sleep Deprivation in Youth

A small number of studies have examined the experimental effects of sleep loss on affective functioning among youth. Baum and colleagues (2014) studied healthy youth between the ages of 13-17 and found that compared to participants in a healthy sleep group (10 hours sleep per night for five nights), those in a sleep restricted group (6.5 hours sleep per night for five nights) reported more feelings of tension/anxiety, anger/hostility, confusion, and fatigue, and reported less vigor. In addition, both participants and their parents reported more oppositionality/irritability and poorer emotional regulation compared to those in the healthy sleep group. No differences were found between sleep conditions in reported depression or hyperactivity/impulsivity.

Talbot and colleagues (2010) reported several adverse effects of sleep deprivation on specific emotions in adolescents ages 10 through 16. Specifically, they found that adolescents (and adults) who were partially sleep deprived evidenced less positive affect. That is, sleep deprived individuals were less likely to report feeling happy, interested, excited, cheerful, energetic, strong, delighted active or proud as compared to participants who were in a rested (control) condition, and also reported increased anxiety. Adding to this, Dagys et al. (2012) found that sleep deprivation resulted in a smaller positivity ratio (ratio of positive to negative emotions).

McGlinchey and colleagues (2011) examined the effects of sleep deprivation on vocal expression of emotions. Following a night of sleep deprivation, in which participants were allowed a maximum of two hours of sleep, adolescents ages 11-15 displayed decreases in positive emotion and increases in negative emotion as evidenced by patterns in their vocal cues. Additionally, sleep-deprived adolescents demonstrated a steeper decrease in positive emotion as compared to the adults in their study, suggesting a possible increased vulnerability to the adverse affective consequences of sleep loss at earlier ages.

Prehn-Kristensen and colleagues (2009) conducted a study that provides evidence for the role of sleep in emotional processing among children. In their study, healthy children 10-13 years old were tested for recognition of emotional pictures presented 11 hours prior, either in the morning (in which case they were tested during the evening), or the evening (in which case they were tested in the morning following a night of sleep). Results indicated that recognition for emotional stimuli (a form of emotional declarative memory) was higher for those who slept in between the period of learning and testing, suggesting better consolidation of emotional information during sleep.

Finally, Leotta, Carskadon, Acebo, Seifer, and Quinn (1997) examined the effects of sleep restriction on emotional reactivity among adolescents ages 11-15 using pictures from the IAPS. Relative to a night of “optimized sleep” (10 hours), a night of “restricted sleep” (4 hours) resulted in higher self-reported anger, sadness, and fear in response to negative images.

Summary of Sleep Deprivation Research

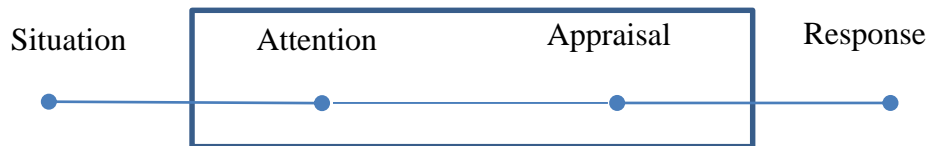
Clearly, research has established that sleep deprivation has a detrimental effect on mood and emotion. Despite these established linkages, a number of important questions remain unaddressed and are therefore of interest in the current study. First, a vast majority of research to date has been conducted in adult samples with results that cannot necessarily be generalized to youth. For example, findings such as those provided by McGlinchey and colleagues (2011) and Dagys et al. (2011) indicate that youth may be more susceptible to the effects of sleep deprivation on emotional functioning than adults. This assertion is consistent with an increased sleep need during earlier periods of development and the fact that emotional development is a progressive process spanning into young adulthood. Moreover, although several areas of subjective ‘emotional processing’ have been examined (e.g., expression, self-reported arousal, recognition), no study has directly examined the impact of sleep deprivation on the regulation of emotional responses to emotionally-charged stimuli. As reviewed in detail below, emotion regulation is defined as “the processes by which we influence which emotions we have, when we have them, and how we experience and express them” (Gross, 2002, p. 282). Thus, relationships between inadequate sleep and emotional regulation may be among the most critical of relationships to consider. The current study therefore seeks to replicate and extend prior findings by examining the impact of experimental sleep restriction on affect and emotion regulatory strategies in a sample of healthy adolescents.

Emotion Regulation

The construct of emotion regulation has garnered much recent attention in the research literature. Emotion regulation involves changes in the “latency, rise time,

magnitude, duration, and offset of responses” in three key, often interrelated domains: behavioral, experiential, or physiological (Gross, 2002). It should be noted that although a response can occur in one or more of these domains, they do not have to correlate (c.f. Gross, 2002).

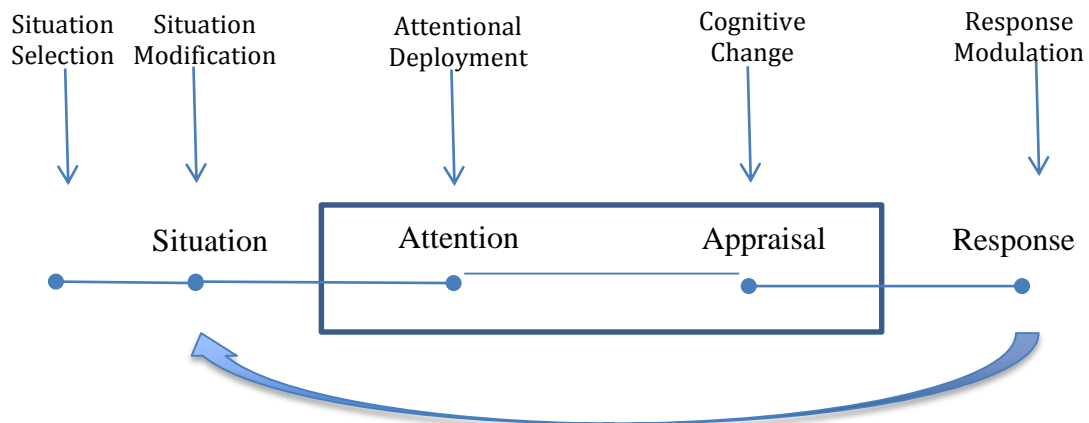
Figure 1. “Modal Model” of Emotion (Gross & Thompson, 2007).



Although emotion regulation can be organized and conceptualized in a multitude of ways, Gross’s model and conceptualization is used here to describe both emotional processing and emotion regulation specifically. Gross and Thompson (2007) describe a basic “modal model” of emotion that depicts the emotion-generative process. This model is illustrated in Figure 1, and follows a situation-attention-appraisal-response sequence. In this model, an organismal “black box” is present between the situation and the individual’s response. The sequence is initiated by a situation, either internal or external, that is psychologically relevant. These situations are then attended to, ultimately allowing for appraisals of the situation. Specifically, the individual may appraise, or make an assessment of, the situation’s valence (e.g., positive, neutral, negative), valence relevance, and familiarity (c.f. Gross, 2007). Finally, these appraisals are thought to give way to a coordinated set of emotional responses (e.g., experiential, behavioral, neurobiological). As an example of how appraisals affect the experienced emotional responses, if an individual were to appraise a given situation (first day at a new school) as having a negative valence (e.g., “No one will like me”), the response may be an experience of unpleasant emotions (e.g., anxiety, sadness) including a possible increase

in heart rate and/or observable frown. However, if the individual were to make a positive appraisal of that same situation (e.g., “I look forward to making new friends”), the response may be an experience of a pleasant emotion (e.g., happiness) and observable indicators (e.g., smile).

Figure 2. Process Model of Emotion Regulation (Gross & Thompson, 2007).



In order to effectively organize the countless emotion regulation strategies one may use, Gross (1995; 1998; 2001; 2002; 2007) has developed a process model of emotion regulation in which he elucidates the five different points in which emotion regulation strategies can have their primary impact on the process in which emotions are produced. These points correspond to different time points in the “modal model of emotion” that was discussed. According to this model, the first set (first four) points are described as “antecedent-focused” emotion regulatory strategies, as they are used prior to when the emotion response tendencies have been in effect (before the emotion starts), and therefore before any changes in behavior or peripheral physiological responding have occurred. These strategies include situation selection, situation modification, attentional deployment, and cognitive change. The final set of strategies (fifth point in the path) is referred to as response modulation and makes up “response-focused strategies,” which include strategies that are used after response tendencies have been produced and an

emotion is already in the process of being generated. As mentioned, emotion response tendencies span experiential, behavioral, and physiological domains (Gross, 2002).

In the first “family” of strategies, situation selection, individuals would act in a way that would alter the likelihood of encountering a situation that is anticipated to produce emotions (either desirable or undesirable) (Gross & Thompson, 2007). An example would be planning to meet a friend for dinner after a rough day. The second set of strategies, situational modification, involves modifying the situation so its emotional impact is changed. In this case, Gross refers to the situation as being external (e.g., physical) rather than internal (e.g., cognition). An example of this would be asking for assistance in solving a difficult problem. It should be noted that according to Gross and Thompson (2007), modifications to internal, or cognitive, situations falls under the fourth set of strategies, cognitive change.

The third set of strategies, attentional deployment, refers to the ways in which individuals direct their attention so that their emotions may be impacted in a given situation. This strategy is often used when the situation cannot be changed or modified. An example would be directing attention toward a positive stimulus to produce more positive emotions, or conversely, directing attention toward a negative stimulus (e.g., a scary image) to produce negative emotions (e.g., anxiety). Gross and Thompson (2007) suggest that attentional deployment can be considered an internal version of situation selection. Distraction and concentration comprise two of the major attention emotion regulation strategies. Distraction includes both completely moving attention away from a situation and focusing attention on a different characteristic of the situation. Concentration involves focusing attention on emotional aspects of a situation.

Rumination would constitute a form of this, specifically when the attention is repeatedly directed to certain feelings and their associated consequences. Rumination has been shown to be related to depressive symptoms among both adolescents and adults (Garnefski & Kraaji, 2006). Developmentally, attentional deployment is among the first emotion regulatory strategies to emerge (c.f. Gross & Thompson, 2007). Young children and even infants tend to look away from unpleasant, aversive stimuli and toward positive stimuli (Gross & Thompson, 2007).

The fourth set of strategies, cognitive change, can occur after one has focused on a characteristic of a situation, and involves modifying our appraisal (assessment) of the situation, which can then change the subsequent emotion response tendencies that will be generated in relation to the situation. This can include either changing our view of a situation or our ability to deal with its demands. Reappraisal is a type of cognitive change specifically in which an individual re-evaluates the situation from a different viewpoint. Reappraisal is considered an effective emotion regulation strategy that has been identified to down-regulate negative emotion (John & Gross, 2004). Although studies utilizing experimental emotion regulation paradigms are more limited in youth than adults, at least one study has found children who (positively) reappraise pictures with threatening content to report decreased emotional reactivity (Carthy, Horesh, Apter, Edge, & Gross, 2010). Also, lack of positive reappraisal is associated with symptoms of depression in early and late adolescents and adults (Garnefski & Kraaji, 2006). Reappraisal is therefore a prominent component of psychological treatments like cognitive-behavioral therapy (CBT). It is important to note however that developmental trajectories of reappraisal ability and success in down-regulating emotional responses are poorly understood at this

time (see McRae et al., 2012). Indeed, children's ability to engage in reappraisal strategies is heavily influenced by their developmental level, specifically by their development of representations of emotions. This development would allow for an understanding of the causes and consequences of emotions, which can allow them to put forth effort to regulate them (c.f. Gross & Thompson, 2007).

While cognitive change (reappraisal) can occur prior to the emotional response, response modulation involves attempts to affect already elicited emotion response tendencies potentially in different domains (physiological, experiential, and behavioral) (Gross & Thompson, 2007). Examples of these strategies are drugs (e.g., beta blockers), alcohol, exercise, or relaxation to counter physiological responses or to reduce the experience of anxiety and depression, or hiding embarrassment to counter behavioral responses. This latter strategy, in which one attempts to hide any visible signs of experiencing a particular emotion (e.g., facial expression), is considered a strategy of "suppression." People may choose to suppress expressive behavior for a variety of reasons, including gaining social approval (e.g., "big girls don't cry") or to hide their intentions (e.g., in a game of poker), or even with no particular goal in mind. This behavioral form of suppression is distinguished from thought suppression, in which one attempts to thwart or avoid particular thoughts.

A few clarifying points about the emotion-regulation process should be made. Figure 2 presents just one cycle of the emotion-generative process. Emotion generation does not stop with the response tendencies, as it is an on-going process (Gross & Thompson, 2007). The arrow in Figure 2 indicates the cyclical nature of this process, illustrating how the emotional response feeds back into the situation- the process is

therefore dynamic and reciprocally determined. As an example, reacting angrily to a boss may put one in a precarious, potentially anxiety-provoking situation. Additionally, it should be made clear that multiple emotion regulatory processes may occur in parallel.

In this study, there is a focus on emotional regulatory strategies used in the fourth point in this process model: appraisal (cognitive change). Of particular interest is the reappraisal emotional regulatory strategy. It should be mentioned that the adaptiveness or subsequent outcome of this emotion regulatory strategies is not of interest, rather, it is the frequency of use and ability to successfully use this strategies that will be examined, and regardless of whether the outcome is good or bad in a real world context. For example, it may in fact be adaptive to make negative appraisals of a situation if it keeps us out of danger.

Research on emotion regulation has been rapidly developing, and has been done in a variety of areas. Emotion dysregulation is prominent in various forms of psychopathology including but not limited to anxiety, depression, eating, and substance-related disorders (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Suveg & Zeman, 2004). Clinical and nonclinical samples have differed in their reported use of adaptive and maladaptive emotion regulatory strategies (Garnefski & Kraaij, 2006). Additionally, emotion dysregulation has been linked to problems in professional work environments, social relationships, productivity, personal sense of meaning, feeling of integration, and self-cohesion (Gross & Munoz, 1995). Conversely, successful emotion regulation has been linked to positive outcomes like good health (Aldao et al., 2010).

Emotional Regulation and Development

There are important developmental differences in the use of emotion regulatory strategies that require consideration. For example, age-related differences in the use of cognitive strategies to regulate emotions have been documented. Specifically, early adolescents report using cognitive strategies, especially positive reappraisal (i.e., attaching a more positive meaning to a situation) less frequently as compared to late adolescents or adults (Garnefski & Kraaij, 2006). Moreover, late adolescents have been found to use cognitive emotion regulatory strategies including positive reappraisal strategies less than adults (Garnefski & Kraaij, 2006). This is consistent with associations between the period of adolescence and marked increases in cognitive capabilities, such as reasoning, information processing, and expertise (Steinberg, 2005). The critical developmental changes that occur during this period have been demonstrated through neuroimaging research. For example, increases in white matter across brain regions can be observed during adolescence (Giedd et al., 1999; Lenroot & Giedd, 2006). In this light, the development and mastery of cognitive emotion regulatory strategies such as reappraisal may be ongoing in adolescence and into adulthood.

The developmental differences in use of reappraisal and suppression strategies are largely consistent with research suggesting that as people age, they make more use of healthy patterns of emotion regulation (e.g., reappraisal) and less frequent use of less healthy emotion regulation strategies (e.g., suppression) (John & Gross, 2004).

Adolescence has been considered a favorable time period to examine emotion regulatory processes, as it is marked by frequent and intense experience of emotions. Adolescents experience heightened emotional arousability associated with the onset of

puberty, however, they have not yet achieved adequate development of regulatory competence, which “creates a disjunction between the adolescent’s affective experience and his or her ability to regulate arousal and motivation” (Steinberg, 2005). Silk, Steinberg, and Morris (2003) examined adolescents’ typical emotion regulation in their daily lives through an experience sampling method and found that different aspects of emotion regulation (e.g., intensity, lability, regulation patterns, and strategy use) were related to behavioral and emotional problems. Specifically, adolescents who evidenced difficulties with regulating their negative emotions were more likely to report experiencing internalizing and externalizing problems. The experience of heightened emotional intensity and lability was related to greater depressive symptoms and behavior problems. Common strategies for regulating emotions in this sample included disengagement (e.g., denial, avoidance) and involuntary engagement (e.g., ruminating, acting impulsively), and was associated with more enduring negative emotional states (e.g., anger, sadness).

Gender differences in the use of specific emotion regulatory strategies have also been found. Research in both youth and adults has documented that males report using suppression strategies more frequently than women (Gullone, Hughes, King, & Tonge, 2010; Gross & John, 2003). Additionally, males report less use of reappraisal compared to females (Gullone et al., 2010).

Present Study

There remains a dearth of research on the effects of experimental sleep deprivation on affect and emotional processing in youth. Only one study has examined emotional regulation specifically and relied on a 3 question measurement of this construct

(Baum et al., 2014). The current study aimed to address these significant gaps in research by assessing an important emotion regulatory strategy, namely cognitive reappraisal, in a sample of adolescents randomized to experimental sleep restriction or an idealized sleep condition. First, research in this area is needed because adolescence constitutes a period of increased risk for emotional/behavioral problems including depression, self-injury and suicide (Muehlenkamp & Gutierrez, 2004), drug and alcohol use (Bauman & Phongsavan, 1999), bullying (Juvonen, Graham, & Schuster, 2003), and sexually inappropriate behaviors (Adams, McClellan, Douglass, McCurry, & Storck, 1995). It is also well established that sleep is generally problematic and/or inadequate in this age group and many adolescents are chronically sleep-deprived (Carskadon, 1990). However, as described above, developmental differences in emotion regulation as well as potential vulnerability to sleep loss caution against extrapolating findings from adult studies to adolescents. Additionally, much of the prior research examining the effects of sleep deprivation on emotions and mood states has been limited to self-report rather than objective and/or behavioral measures.

The overall aim of the current study was to extend experimental sleep research in adolescence through the use of a multi-method approach for measuring emotion-based outcomes. A between-groups experimental design (including sleep restriction and idealized sleep conditions) was used among a sample of healthy adolescents, ages 13 to 17. Youth were randomized to either one-night sleep restriction (4 hours) or idealized sleep (9.5 hours) and completed a battery of in-lab emotional processing tasks and measures the next day. The overall design and measures used in this study aimed to

provide a better understanding of the mechanisms through which sleep duration impacts affective functioning during the adolescent years.

Hypotheses

Primary Aims.

1) Affect. Four components of affect were assessed: (1) positive affect and (2) negative affect, broadly speaking, in addition to (3) state anxiety and (4) trait anxiety. Based on previous research (e.g., Talbot et al., 2010; Cartwright, Luten, Young, Mercer, & Bears, 1998; Dagys et al., 2012; Vardar et al., 2007; Sagaspe et al., 2006), it was predicted that adolescents randomized to a one-night sleep restriction condition (4 hours) would report less positive affect, as measured by the Positive and Negative Affect Schedule for Children-Positive Affect subscale (PANAS-C; Laurent et al., 1999), and more state anxiety, as measured by the State-Trait Anxiety Inventory for Children-State Anxiety subscale (STAIC; Spielberger, 1973) in comparison to adolescents in the one-night idealized sleep group. Negative affect, per the Positive and Negative Affect Schedule for Children-Negative Affect subscale, and trait anxiety, per the State-Trait Anxiety Inventory for Children- Trait Anxiety subscale (STAIC; Spielberger, 1973), were also assessed.

2) Emotional reactivity. Emotional reactivity was assessed by the Self-Assessment Manikin (SAM) arousal and valence ratings (Bradley & Lang, 1994) in response to picture stimuli from the International Affective Picture System (IAPS; Lang et al., 2008). Based on prior research in youth (e.g., Leotta et al., 1997) and adults (e.g., Franzen, et al., 2009; Yoo et al., 2007), emotional reactivity in response to negative emotional stimuli was predicted to be greater in the sleep restricted group (as evidenced

by more negative valence ratings and higher arousal/intensity ratings per self-report), in comparison to in the idealized sleep group. Emotional reactivity in response to neutral and positive stimuli was also assessed.

3) *Emotion regulation.* Given the adverse effects of sleep deprivation on cognitive/neurobehavioral functioning (e.g., memory, sustained attention, behavioral inhibition, reaction time; Sadeh, Gruber, & Raviv, 2003; Pilcher & Huffcutt, 1996), it was hypothesized that sleep restriction would interfere with adolescents' success in using certain regulatory strategies for modulating their emotional responses. Specifically, compared to participants in an idealized sleep condition, adolescents who were partially sleep deprived would exhibit: 1) less ability to use reappraisal strategies (referred to here as *Reappraisal Ability*; operationally defined as quantity of reappraisal statements generated, when prompted, in response to negative picture stimuli from the IAPS); and 2) decreased efficacy of reappraisal strategies in down-regulating negative emotions (e.g., frustration, disgust, fear, sadness) (referred to here as *Reappraisal Efficacy*; operationally defined as the difference in SAM valence ratings for negative IAPS images that are simply viewed versus reappraised).

4) *Mediating role of emotion regulation.* Based on the well-established relationship between inadequate sleep and affective disturbances across the life span, as well as experimental data showing sleep loss to directly impact emotion regulation and emotional reactivity, it was hypothesized that reappraisal ability and reappraisal efficacy would mediate the relationship between sleep condition and affective responses (positive and negative affect, state and trait anxiety).

Secondary Aims.

1) Sex differences. It was predicted that sex differences would emerge with respect to emotional reactivity and emotion regulation. Based on prior research (Gullone et al., 2010; Gross & John, 2003; Silk et al., 2003; van der Helm et al., 2010), it was predicted that females would report higher intensity of emotional reactivity to negative stimuli, and higher reappraisal ability and efficacy, across sleep groups.

2) Age differences. Based on age-related differences in brain development and related use of cognitive emotion regulatory strategies (John & Gross, 2004; Garnefski & Kraaij, 2006; Steinberg, 2005; Giedd et al., 1999; Lenroot & Giedd, 2006), it was hypothesized that age would be positively associated with both reappraisal ability and efficacy across sleep conditions. That is, it was predicted that older adolescents as compared to younger adolescents would generate a greater number of reappraisals and would be more effective in using reappraisal strategies to down-regulate their negative emotional responses.

Method**Participants**

A total of 42 adolescents (18 male and 24 female) between the ages of 13 and 17 ($M = 14.86$, $SD = 1.32$) completed the study (information regarding participant flow is presented below). A power analysis was conducted and determined that this sample size was sufficient to detect moderate effects. The final sample was diverse: 57.1% Caucasian, 23.8% African American, 14.3% Asian, and 4.8% of mixed race; 16.7% Hispanic, 83.3% Non-Hispanic. Inclusion criteria were: a) absence of current psychiatric disorder or significant emotional/behavioral problems; b) absence of lifetime history of

Major Depressive Disorder; c) absence of any suicidal thoughts, behaviors, or previous attempts; d) absence of diagnosis or suspicion of a sleep disorder, e) absence of a chronic medical condition potentially affecting sleep (e.g., atopic dermatitis, pain-related syndromes); f) absence of the use of any medication or supplement potentially impacting mood/sleep (e.g., stimulants, anti-histamines, illicit substances); g) enrollment in a mainstream classroom; h) English-speaking; and i) maintaining a regular sleep schedule during the week of actigraphy and compliance with the assigned sleep condition.

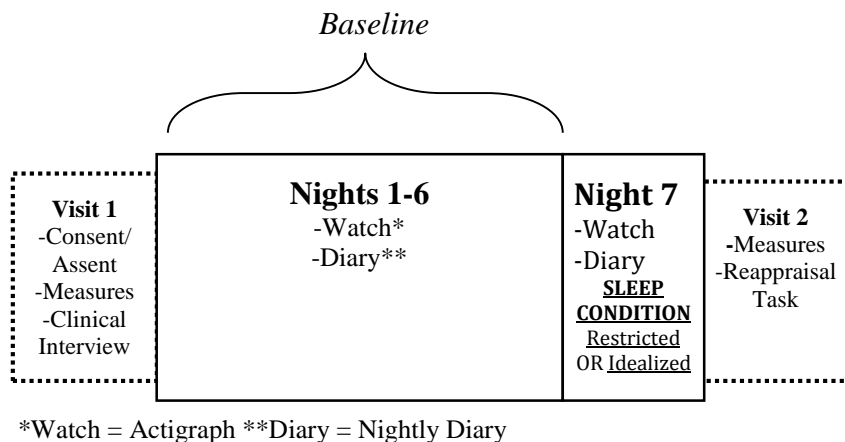
Procedure

Participants were recruited from the community via flyers posted at different universities, community colleges, high schools, and hospitals, online community forums (e.g., craigslist), educational outreach at local health fairs and student events, and through phone calls made to families whose contact information was provided in local school directories. Interested participants contacted the study coordinator to receive detailed study information, and completed a brief phone screen to determine eligibility (according to the criteria listed above). Eligible teenagers were invited to complete a diagnostic assessment at the University of Houston.

A timeline of study participation is provided visually in Figure 3. At the initial appointment, families provided informed consent after all study procedures were explained in detail. Families were informed that they may discontinue their participation at any time. All consenting families completed a comprehensive diagnostic assessment including semi-structured diagnostic interviews (KSADS-PL-C; Kauffman et al., 1997) with adolescents and parents and child and parent-report questionnaires. All diagnostic evaluations were conducted by graduate students and research assistants under the

supervision of a licensed clinical psychologist. Based on this comprehensive evaluation, adolescents who did not fulfill all of the aforementioned criteria for inclusion were considered to be ineligible for further participation in the study, and were therefore excluded. Participants who are ineligible were provided with referral information for psychological services in the community as appropriate.

Figure 3. Diagram of Study Timeline.



Participants who did not meet any of the exclusion criteria were asked to wear wrist actigraphs (a watch-like device that measures movement as a proxy for sleep) for 7 nights (to ensure a normal sleep schedule prior to sleep manipulation and to rule-out circadian sleep disorders). To help assure compliance with actigraphy, subjects were asked to keep a daily sleep log during the same period. To ensure the integrity of the sleep manipulation (i.e., to ensure adolescents were not sleep-deprived prior to the experimental night), all participants were asked to average no less than 7 hours of sleep per night during the study week. Average total sleep time (TST) across the week was

confirmed by actigraphy and participants who averaged less than 7 hours a night were deemed ineligible.

After wearing the watch for six nights, participants were contacted by the investigators on night seven. Self-reported sleep was assessed. If participants reported compliance with the baseline week requirements and normal baseline patterns, they were then randomly assigned to one of two sleep conditions using a randomization table stratified by age and sex: either *Restricted Sleep* (limiting total sleep time to 4 hours) or *Idealized Sleep* (9.5 hours of total sleep) to be conducted at home and confirmed with actigraphy. Total sleep duration of these conditions is consistent with prior experimental sleep research studies in adolescents (e.g., Randazzo, Muehlbach, Schweitzer, & Walsh, 1998; Fallone, Acebo, Arnedt, Seiter, & Carskadon, 2001; Carskadon & Dement, 1982). Specific instructions and guidance for manipulating sleep schedules were provided to ensure compliance with the assigned sleep condition as well as duration of waking hours prior to testing. Adolescents assigned to the restricted condition were asked to go to bed two hours later than what they consider to be their typical bedtime and sleep for 4 consecutive hours. Adolescents who were assigned to the idealized sleep group were asked to go to bed at their typical bedtime and sleep for 9.5 consecutive hours.

Actigraphy was used to confirm compliance with both the baseline week of sleep as well as completion of the sleep condition. Participants were considered to be non-adherent to their assigned sleep condition if they deviated from their expected TST by more than 2 hours (i.e., restricted sleep participants were required to sleep for 2-6 hours and idealized sleep participants were required to sleep for 7.5-11.5 hours), or if they did not go to bed around the time specified for their respective condition (e.g., restricted

sleep participants would have been considered non-adherent if they went to bed at 6 A.M.).

On the day following the experimental night, adolescents assigned to sleep restriction were instructed not to drive, operate heavy machinery, or engage in any other behaviors that may place them at risk of injury. Instructions for safely and effectively re-adjusting sleep schedules were provided on the day of the in-lab assessment.

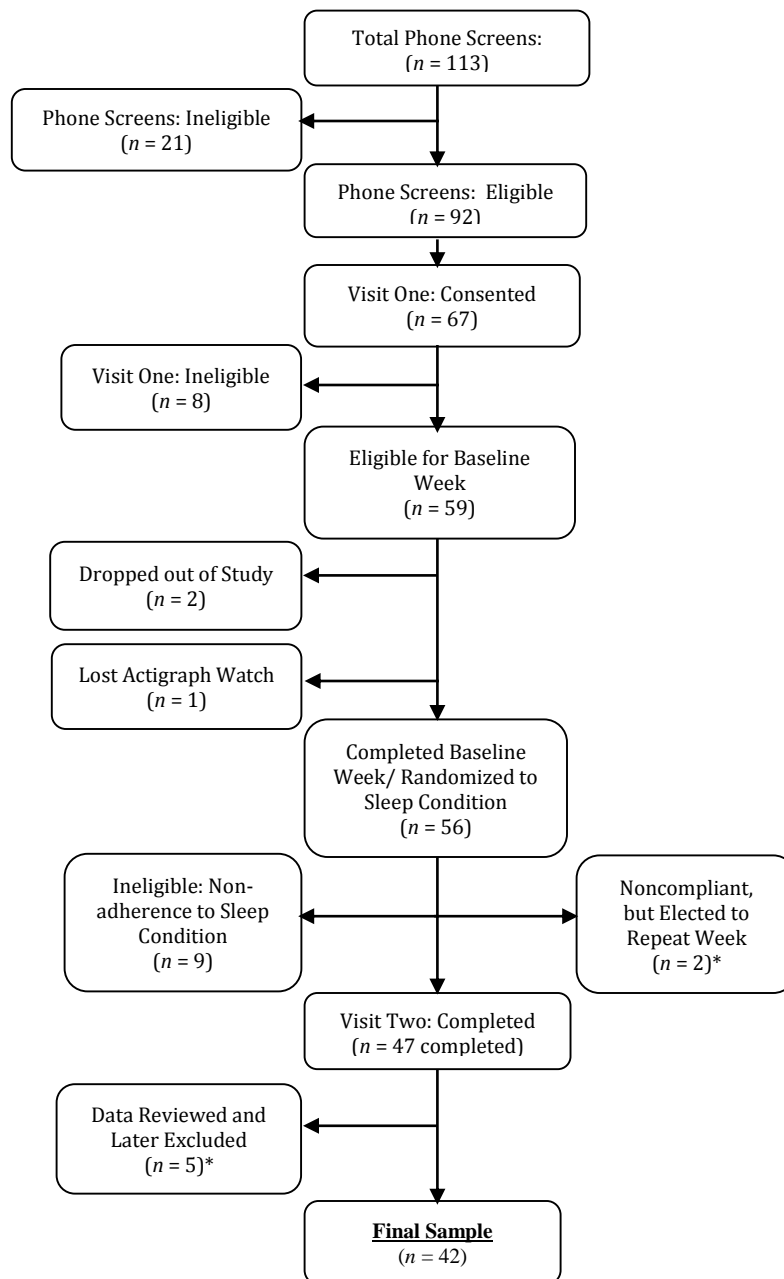
Experimental sleep nights were intentionally set as a Friday or Saturday so as to not interfere with adolescents' school schedules. On the day following the experimental night, at 12:00 pm, adolescents returned to the University of Houston and completed a battery of laboratory-based tasks. Families completing all aspects of the study were compensated with a \$50 gift card (to either Target or Amazon) for their time and efforts.

Participant Flow

Figure 4 provides a visual summary of participant flow. A total of 113 families completed initial phone screens for the study, of which 92 were eligible, and 67 consented to participate. Of the 67 participants who were consented, 59 participants were eligible for the baseline week of sleep. Twenty five consenting participants were excluded for various reasons: Eight were deemed ineligible to continue during the initial assessment due to the presence of psychopathology and/or significant sleep problems; two dropped out, one lost the actigraphy watch and therefore was not able to have their data confirmed as adhering to the assigned sleep condition, and nine were excluded due to non-adherence to an assigned restricted sleep condition. Five of the participants completed the entire study but their data were later excluded (one because of the presence of excessive night awakenings as indicated by actigraphy data, and four participants who

were assigned to the restricted sleep group removed their watches much earlier than noon, and therefore we were not able to verify their adherence to the sleep

Figure 4. Visual Summary of Study Participation.



*Participants re-randomized to sleep condition- both successfully completed second attempt.

**1 Participant excluded because of the presence of excessive night awakenings as indicated by actigraphy data, and 4 participants who were assigned to the restricted sleep group removed their watches much earlier than noon.

Adapted from consort chart by Baum et al. (2014)

condition). It should be noted that two additional participants were found noncompliant with the randomized sleep condition assignment but had elected to repeat the sleep protocol, including the experimental night, and were re-randomized to a sleep condition. Both of these participants were adherent during the second attempt. The final sample included 42 participants.

Data collection spanned the months of May to February of the following year and 36% of adolescents participated during the summer months. These participants were instructed to maintain a school sleep schedule during the week of participation. Participants whose sleep schedules varied vastly from the school year sleep schedule were excluded.

Measures

Eligibility Evaluation.

The following measures were used primarily to evaluate eligibility for the study (e.g., providing information about any presence of psychopathology or sleep problems). Specific report of symptoms on these measures were not of interest in the current study and will not be reported.

Clinician-Based Measures.

Kiddie Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime Version (K-SADS-PL; Kauffman et al., 1997). The K-SADS-PL is a semi-structured diagnostic interview that assesses a broad range of anxiety, mood, and externalizing disorders in children and adolescents according to the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 2000). The interview was administered to all

adolescents and one of their parents separately. Diagnoses based on the K-SADS-PL have been demonstrated to be reliable and valid (Kaufman et al., 1997). A positive diagnosis based on either adolescent or parent report served as an exclusionary criterion for this study.

BEARS Sleep Screen (Owens et al., 2005). The BEARS is a clinician-administered brief screen for sleep disorders that asks about bedtime problems, excessive daytime sleepiness, awakenings during the night, regularity and duration of sleep, and sleep-disordered breathing. Endorsement of any of these sleep problems was followed up with further questions to assess for the presence of a sleep disorder, which was an exclusionary criterion for the study.

Actigraphy.

A wrist actigraph (Micro Sleepwatch, Ambulatory Monitoring Inc.) is a small watch-sized device that is worn on the non-dominant hand 24 hours a day and measures movement. The units collect and store data continuously over an extended period. Daily event markers provide specific information regarding sleep/wake times. Following use, data from the unit are downloaded onto a computer in the laboratory and scored by a computer-generated algorithm that has been shown to be reliable in identifying sleep and wake periods. It has been used extensively in infants and children and there are no risks associated with its use. Actigraphy has been shown to be a reliable and valid indicator of sleep across age groups (c.f. Sadeh et al., 2003). Moreover, it is considered to provide a naturalistic assessment of sleep. Actigraphy data was used primarily to confirm adherence to TST during both the baseline week as well as experimental night.

Parent-Based Measures.

General Information Sheet. A general information sheet was used to collect demographic and developmental information including age, gender, race, familial characteristics, SES, child medical history, developmental milestones, etc.

Revised Children's Anxiety and Depression Scale, Parent Report (RCADS-P; Chorpita, Yim, Moffit, Umemoto, & Francis, 2000). The RCADS-P is a 47-item adaptation of the Spence Children's Anxiety Scale and is intended to measure parent-report of symptoms consistent with DSM-IV (American Psychiatric Association, 1994) criteria for anxiety and mood disorders. The format is identical to the child-report version (RCADS). The RCADS-P has demonstrated high internal consistency for all subscales and high convergent/divergent validity in both clinical and school-based samples of children and adolescents (Ebesutani, Bernstein, Nakamura, Chorpita, & Weisz, 2010; Ebesutani et al., 2011). Additionally, its six-factor structure has been empirically supported (Ebesutani et al., 2011).

Child Behavior Checklist for Ages 6-18 (CBCL; Achenbach, 1991). The CBCL is a 113-item, standardized, parent-report scale assessing a broad range of behavioral problems, and social and academic functioning. Parents rate their children's behavior "now or within the past 6 months" on a 3-point Likert scale (0 = not true, 1 = somewhat or sometimes true, and 2 = very true or often true). Examples of questions are "acts too young for his/her age" and "suspicious." A variety of broad and narrow-band syndrome scales and DSM-oriented scales can be derived from these items. The CBCL is one of the most extensively tested rating scales available and possesses excellent psychometrics (Achenbach, 1991). Internal consistency of this measure has been shown to be high

(Achenbach, 1991; Albores-Gallo et al., 2007). Scores on the CBCL have been found to discriminate between clinical and normal samples (Achenbach & Edelbrock, 1983).

Children's Sleep Habits Questionnaire (CSHQ; Owens, Maxim, Nobile, McGuinn, & Msall, 2000). The CSHQ is a comprehensive, parent-report measure for assessing children's sleep. It yields both a total score and eight subscales scores reflecting key sleep domains that encompass a range of medical and behavioral sleep problems in children. These include bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night wakings, parasomnias, sleep-disordered breathing, and daytime sleepiness. Parents complete the 35-item questionnaire based on sleep behaviors that occur over a "typical" recent week. Each item is rated on a scale corresponding with frequency, with "rarely" indicating the relevant sleep behavior occurring zero to one time/week, "sometimes" indicating two to four times/week, and "usually" indicating five to seven times/week. Several items are reversed scored and a higher score on this scale indicates more disturbed sleep. This measure was used primarily to detect those who may have a sleep disorder that disqualifies them for the study. Acceptable internal consistency, test-retest reliability, and validity of the measure in differentiating community from sleep-disordered individuals have been demonstrated (Owens, Spirito, & McGuinn, 2000).

Child-Based Measures.

Daily sleep diary. Participants were asked to keep record of several sleep variables during their baseline week (including the night of their experimental sleep condition). Specifically, they were asked to report their bedtime and wakeup time, the amount of time it took them to fall asleep, number of awakenings at night, sleep onset latency (approximately how long it took them to fall asleep), total sleep time, and any

unusual occurrences during the night. Additionally, they were asked to report on the quality of their sleep, number and duration of naps each day, any intake of caffeine, alcohol, or medications, exercise, and activity one hour prior to bedtime. Sleep diaries are considered an important subjective measure of sleep.

Revised Children's Anxiety and Depression Scale (RCADS; Chorpita et al., 2000). The RCADS is a 47-item adaptation of the Spence Children's Anxiety Scale and is intended to measure children's self-report of symptoms consistent with DSM-IV (American Psychiatric Association, 1994) criteria for a range of anxiety disorders (e.g., Separation Anxiety Disorder, Social Phobia, Obsessive-Compulsive disorder, Panic Disorder, Generalized Anxiety Disorder) as well as Major Depressive Disorder. Participants are asked to indicate on a four-point Likert scale (1 = never, 4 = always) the extent to which they endorse different statements like "I worry about things" or "I feel sad or empty." A total anxiety score summing across the items as well as subscale scores that correspond with the 6 diagnostic categories can be computed. Strong psychometric properties of this measure have been demonstrated (Chorpita et al., 2000; de Ross, Gullone, Eleonra, & Chorpita, 2002). Examination of the factor structure of the RCADS suggests reasonable fit with the six-factor model that corresponds to the 6 diagnostic subscales (de Ross et al., 2002).

Sleep Self Report (SSR; Owens et al., 2000). The SSR is a 26-item child-report measure assessing the same sleep domains as the CSHQ. Similar to the CSHQ, the SSR yields a total sleep problems score and subscales reflecting key sleep domains that encompass a range of medical and behavioral sleep problems in children. Children complete the questionnaire according to sleep behaviors that occur over a "typical" recent

week. This measure was used primarily to detect those who may have a sleep disorder that disqualifies them for the study. Good internal consistency and convergent and divergent validity have been documented (Orgiles, Owens, Espada, Piqueras, & Carballo, 2012; Gregory, Willis, Wiggs, & Harvey, 2008).

Youth Self Report (YSR; Achenbach, 1991). The YSR is a 112-item youth-report scale (for youth ages 11-18) assessing a broad range of behavioral problems, and social and academic functioning. The YSR is the self-report version of the CBCL and shares the majority of the items and scales. The YSR is one of the most extensively tested rating scales available and possesses excellent psychometrics (Achenbach, 1991) including good internal consistency for the broadband (Internalizing Problems and Externalizing Problems) and Total Problems scale scores (Steinhausen & Metzke, 1998) and convergent validity.

Laboratory-Based Assessment following Experimental Night.

Positive and Negative Affect Schedule for Children (PANAS-C; Laurent et al., 1999). The PANAS-C is a self-report measure designed to assess children's experience of positive and negative affect. There are a total of 27 emotions listed, 12 of them positive (e.g., happy) and 15 of them negative (e.g., upset), and for each of these emotions participants will be asked to provide a rating using a 5-point Likert scale (1 = very slightly or not at all, 5 = extremely) based on how they feel "right now." Strong psychometric properties of this measure have been established including good convergent, discriminant, and structural validity as well as high internal consistency (Laurent et al., 1999). The PANAS-C was administered both at the initial assessment (to serve as a baseline) as well as following the sleep manipulation.

State-Trait Anxiety Inventory for Children (STAIC; Spielberger, 1973). The STAIC consists of two separate self-report, 20-item scales that assess State Anxiety (A-State) and Trait Anxiety (A-Trait) among youth. Youth were asked to indicate how they both currently (state anxiety) and generally feel (trait anxiety). Whereas the A-State scale is intended to measure short-term, transitory anxiety, the A-Trait scale is meant to measure longer-term, more stable tendencies to experience anxiety. Good reliability has been shown, as well as good validity in differentiating between emotionally disturbed children from normal children (Montgomery & Finch, 1974). The STAIC will be administered both at the initial assessment (to serve as a baseline) as well as following the sleep manipulation.

Epworth Sleepiness Scale (ESS; Johns, 1991). The ESS is a self-report questionnaire to assess an individual's general level of daytime sleepiness. Participants are asked to indicate their "chance of dozing" in eight different scenarios such as "sitting and reading," "watching TV," and "in a car, while stopped for a few minutes in the traffic" on a scale of 0-3, with 0 indicating "would *never* doze" and 3 indicating "*high* chance of dozing." This measure has evidenced high internal consistency and reasonable test-retest reliability (Johns, 1992). The ESS was administered both at the initial assessment (to serve as a baseline) as well as following the sleep manipulation.

International Affective Picture System (IAPS; Lang et al., 2008). Images were selected from the International Affective Picture System (IAPS; Lang et al., 2008). A total of 40 images were selected based on published normative valences (Lang et al., 2008) for children and adults (when child normative ratings for select images were not available) to categorize as positive, neutral, and negative images. Valence norms were

provided by Lang and colleagues (2008) on a scale ranging from 1 to 9 with 9 representing the most positive valence, 1 representing the most negative valence, and 5 representing a neutral valence. Of the 40 included images, 8 were considered positive (valence ratings ranging from 7.24 to 8.13, average = 7.68), 8 were considered neutral (valence ratings ranging from 4.95 to 5.42, average = 5.15), and 24 were considered negative (valence ratings ranging from 1.91 to 3.52, average = 2.76).

Half of the negative images were randomized to a “View” condition and the other half to a “Reappraise” condition. Images used in the two conditions did not differ in average valence or arousal ratings (based on normative data), and this was verified statistically. There were 4 picture conditions in total: Positive View, Neutral View, Negative View, and Negative Reappraise, hereafter referred to as Positive Images, Neutral Images, Negative Images, and Reappraised Negative Images, respectively. Table 1 shows the mean normative ratings by picture group. Images from these four conditions were pseudo-randomized in the order of presentation with the constraint that no more than two picture conditions were presented consecutively. All participants viewed the images in the same order. The negative images (both in the View and Reappraise conditions) purposefully included threatening content (e.g., violence, disasters) to elicit negative emotions. All images were reviewed by 3 child psychologists for age appropriateness and were approved by the university Institutional Review Board.

Affective Rating Form. The Self-Assessment Manikin (SAM) (Bradley & Lang, 1994) is extensively used in studies utilizing IAPS images and consists of two rating dimensions: valence and arousal/intensity. Each of these scales ranges from 1 to 9, with 9 being the most positive valence or the highest intensity/arousal, and 1 presenting the most

negative valence or least intensity/arousal. The normative IAPS information used to select images was based on these SAM ratings. We note that many other studies (e.g.,

Table 1

Normative IAPS Ratings (Lang et al., 2008) By Picture Type For Selected Images in the Study

Picture Type	Mean Valence	Mean Arousal	Lowest Valence	Highest Valence
Positive Images	7.68	5.76	7.24	8.13
Neutral Images	5.15	2.89	4.95	5.42
Negative Images	2.57	5.49	1.91	3.25
Reappraised Negative Images	2.62	5.87	1.92	3.52

Carthy et al., 2010; Ochsner et al., 2004; McRae et al., 2012) using similar cognitive reappraisal tasks have used a rating scale that included only one dimension and only allowed for rating of negative emotion (e.g., a participant would be asked to rate how negative they feel on a scale of 1-8). This study utilized the SAM rating scale for two primary reasons: (1) to allow participants to report positive or neutral emotional valence reactions to images that are otherwise classified as negative based on published normative data, and (2) so that positive and neutral images can also be included in the study to assess emotional reactivity to these picture types. Previous studies utilizing SAM for IAPS images have found excellent internal consistency for both valence and arousal ratings (Bucks, da Silva, & Han, 2005; Lang et al., 2005).

Cognitive Re-appraisal Task. In order to assess cognitive re-appraisal, the Adolescent Cognitive Reappraisal Task was created which incorporated aspects of the Reactivity and Regulation-Images (REAR-I) task developed by Carthy and colleagues (2010) as well as tasks developed in other studies examining cognitive reappraisal (e.g.,

McRae et al., 2012; Ochsner et al., 2004). This task allowed us to simultaneously assess emotional reactivity, which as discussed is a related yet separate construct from emotion regulation. The task consisted of participants viewing 40 images of varying valences and intensities under conditions of either simply viewing or reappraising the images, and then providing their affective ratings.

Task Procedure. A standardized script and testing protocol was developed and used by all research personnel administering the Adolescent Cognitive Reappraisal Task. The staff member administering the task was blind to the participants' sleep condition when possible. First, research staff spent about 15 minutes teaching participants how to use the cognitive reappraisal strategy and participants completed a few practice trials in which they received feedback on their use of this strategy. Research personnel ensured that participants adequately understood the reappraisal strategy before proceeding to the actual task. Specific methods of reappraisal taught included (1) distancing oneself from the picture (e.g., "It's not real," "it's just a movie," "it's photoshopped"), (2) thinking that things would get better over time, and (3) thinking of a more positive explanation (e.g., in reference to a picture of a girl sitting on a floor with her head down, "the girl has simply fallen asleep").

Participants were asked to practice each of these three approaches using a sample image and were asked to use any or all of the presented strategies. They were also told that they could use a different reappraisal strategy not presented. During the presentation of the reappraisal images, participants were required to state out loud their reappraisal statements, which were recorded verbatim by the research assistant. The actual task lasted 16 minutes and consisted of 40 trials (one for each image). Each trial consisted of

instruction for the upcoming image (i.e., “View” or “Reappraise”) lasting for 4 seconds, presentation of the IAPS image for 10 seconds, a slide containing the SAM rating dimensions for 8 seconds (prompting participants to provide ratings on a paper form), and a blank slide lasting 2 seconds that served as a transition slide to the next trial. Figure 5 provides a visual depiction of the administration timeline for each trial.

Coding and Variables Used in Analyses. Similar to Carthy and colleagues (2010), *Reappraisal Ability*, *Reappraisal Efficacy*, and *Emotional Reactivity* scores were created for each participant. Reappraisal Ability scores were based on the actual reappraisal statements provided by participants. Three study personnel coded these statements and each provided a 0-2 rating for each statement. 2 points were given for a statement that included an appropriate reappraisal, 0 points were given for no response or if a non-reappraisal response was given (e.g., a negative statement without any attempt to reappraise), and 1 point was assigned if a partial reappraisal statement was made. Such responses included statements that technically contained a reappraisal but one that was unlikely to render a picture less threatening (e.g., in response to an image of a cockroach on a slice of pizza, “they like them on their pizza”). Points were summed across raters to produce a total Reappraisal Ability score for each participant, which was used in the final analyses. These scores could range from 0 to 6, with a 6 representing 100% successful reappraisals (as judged by all three coders) and 0 representing 0% successful reappraisals.

Additionally, a *Reappraisal Efficacy* score was created for each participant, computed by subtracting the mean valence rating from the “View” images from the mean valence rating for the “Reappraise” images. This provided a difference score for each

participant that reflected reduction in negative emotion produced by use of reappraisals (higher score = higher reduction in negative emotion).

Finally, *Emotional Reactivity* scores were also derived based on each of the four image categories. All variables derived from this task are presented in Table 2.

Figure 5. Timeline for trials in the Adolescent Cognitive Reappraisal Task.

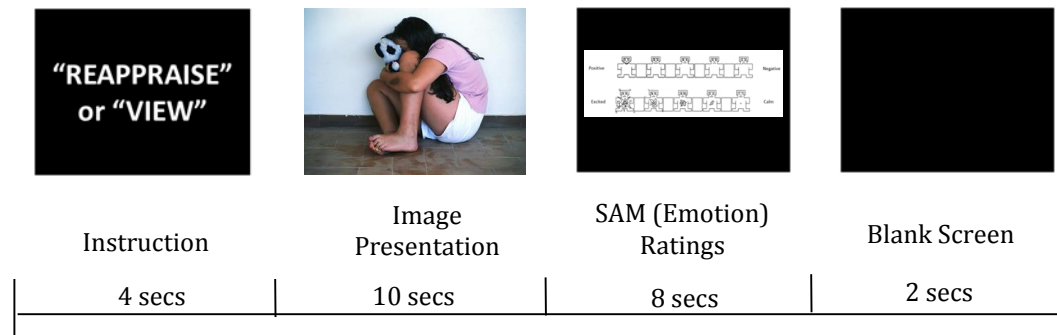


Table 2

Summary of Laboratory-Based Assessment Following Restricted/Idealized Sleep

Construct Assessed	Measure/ Task
Affect	Positive and Negative Affect Schedule for Children (PANAS-C) State-Trait Anxiety Inventory for Children (STAIC)
Sleepiness	Epworth Sleepiness Scale (ESS)
<i>Emotion Regulation</i>	
Reappraisal Ability	Adolescent Cognitive Reappraisal Task
Reappraisal Efficacy	Adolescent Cognitive Reappraisal Task
<i>Emotion Reactivity</i>	
Positive Image Reactivity	IAPS image ratings
Neutral Image Reactivity	IAPS image ratings
Negative View Image Reactivity	IAPS image ratings
Negative Reappraised Image Reactivity	IAPS image ratings

Results

Preliminary Analyses

Data were first examined to ensure that assumptions for multivariate/parametric tests were met, including normality (i.e., lack of significant skew or kurtosis) of dependent variables and homogeneity of variances and covariances across cells (Field, 2009). Variables used in analyses generally met these requirements with the exception of negative affect on the PANAS-C, which was positively skewed for both Time 1 (baseline) and Time 2 (post-experimental) points. Due to the robustness of the tests used and because the groups had equal sample sizes (Field, 2009; Maxwell & Delaney, 2004; Howell, 2013), transformations were not conducted.

Theoretically the two sleep condition groups should not differ on any baseline variables given that participants were randomized into these conditions. In order to verify this assumption, a multivariate analysis of variance (MANOVA) was run between groups with dependent variables derived from self-report measure scales completed at baseline (ESS, PANAS-C Positive Affect and Negative Affect scales, STAIC A-State and A-Trait scales). The overall multivariate effect was not significant [$F(5, 36) = .165, \eta^2 = .022, p = .974$] suggesting no significant differences between the groups in reported level of sleepiness, positive or negative affect, and state or trait anxiety at the initial visit. Follow-up univariate analyses confirmed a lack of significant group differences for these variables. Means for each of these variables are listed in Table 3.

Demographic variables were also compared between groups. An independent samples t-test showed no group differences in age [$t(40) = .563, p = .577$]. Additionally, chi-square tests were conducted to test for differences in gender and ethnicity between

groups and showed no significant differences between the sleep conditions (Gender: $\chi^2(1) = .389, p = .533$; Ethnicity: $\chi^2(4) = 4.863, p = .302$).

Average sleep duration across the entire sample for the baseline week was 7.88 hours ($SD = 0.89$). Comparison of average total sleep duration between the groups (Restricted: $M = 7.83, SD = 0.95$; Idealized: $M = 7.93, SD = 0.85$) revealed no significant difference in TST during the baseline week [$t(40) = -.358, p = .722$]. Overall, these results indicate that sleep condition groups did not differ in terms of sleepiness, affect, demographic variables, or baseline duration of sleep, prior to completion of the assigned sleep condition.

Table 3

Descriptive Means for Baseline Variables and Comparisons Between Sleep Condition Groups

Variable	Overall Mean (SD)	Restricted Sleep Mean (SD)	Idealized Sleep Mean (SD)	F-ratio	η^2	p
ESS						
<i>Sleepiness</i>						
Time 1	7.53 (3.75)	7.83 (4.23)	7.24 (3.28)	.257	.006	.615
Time 2	9.10 (5.50)	12.10 (5.09)	6.10 (4.16)			
PANAS						
<i>Positive Affect (PA)</i>						
Time 1 PA	42.34 (8.06)	43.05 (6.12)	41.62 (9.72)	.325	.008	.572
Time 2 PA	33.03 (10.24)	30.02 (11.00)	36.05 (8.64)			
<i>Negative Affect (NA)</i>						
Time 1 NA	19.92 (5.40)	19.97 (4.76)	19.86 (6.09)	.005	<.001	.946
Time 2 NA	16.77 (2.33)	17.30 (3.00)	16.25 (1.24)			
STAIC						
<i>State Anxiety</i>						
Time 1 A-State	28.33 (3.18)	28.00 (3.05)	28.67 (3.35)	.455	.011	.504
Time 2 A-State	29.32 (3.98)	31.38 (3.58)	27.25 (3.28)			
<i>Trait Anxiety</i>						
Time 1 A-Trait	27.29 (4.05)	27.26 (3.38)	27.32 (4.71)	.002	<.001	.964
Time 2 A-Trait	29.56 (4.30)	30.65 (4.07)	28.48 (4.33)			

Note: Results from significance tests for Time 2 variables are presented elsewhere as they were included in a different model that included covariates.

Sleep Manipulation Check.

In order to ensure that the sleep manipulation was effective, Total Sleep Time (TST) on the experimental night and subjective report of sleepiness the following day were compared between groups. An independent samples t-test confirmed that TST for those in the restricted sleep group ($M = 4.62$ hours, $SD = 0.69$) was significantly less than in the idealized sleep group ($M = 9.30$ hours, $SD = 0.73$) [$t(40) = -21.36, p < .001$]. In order to verify that sleep condition had an effect on level of sleepiness, a general linear model was conducted with the total ESS score from second visit as the dependent variable, sleep condition as the between-subjects factor, and total ESS score from baseline as a covariate. The effect was significant [$F(1, 39) = 18.89, \eta^2 = .326, p < .001$] and examination of the means confirmed that those in the restricted group (*Marginal Mean* = 11.94, $SE = 0.92$) reported a higher level of sleepiness than did those in the idealized group (*Marginal Mean* = 6.26, $SE = .92$). These results together validate the effectiveness of the sleep manipulation.

Primary Analyses

As the study has a large number of dependent variables, several were grouped together conceptually in multivariate analyses to reduce the possibility of Type I and Type II errors. A series of multivariate general linear models (GLMs) were conducted to compare means of between-group outcomes. In these analyses sleep condition was the between subjects factor. Significant multivariate effects were followed by examination of univariate tests to determine which means significantly differed between groups. Primary analyses were grouped by those related to 1) affect scales (i.e., PANAS-C Positive

Affect, PANAS-C Negative Affect, STAIC A-State, and STAIC A-Trait), 2) emotional reactivity variables, and 3) reappraisal variables.

Affect. A general linear model (GLM) was conducted with sleep condition as the between subjects factor and the following post-experimental (Time 2) Variables as the dependent variables: PANAS-C Positive Affect, PANAS-C Negative Affect, STAIC A-State, STAIC A-Trait. Additionally, baseline (Time 1) versions of these variables were included as covariates in this analysis. The overall multivariate effect was significant [$F(4, 33) = 9.32, \eta^2 = .531, p < .001$]. Follow-up univariate analyses revealed that participants in the restricted sleep condition reported lower positive affect [$F(1, 36) = 10.68, \eta^2 = .229, p = .002$], higher state anxiety [$F(1, 36) = 33.24, \eta^2 = .480, p < .001$], and higher trait anxiety [$F(1, 36) = 7.49, \eta^2 = .172, p = .010$] relative to those in the idealized group. There was no significant difference in the means for negative affect [$F(1, 36) = 2.69, \eta^2 = .069, p = .110$]. Marginal means (removing variability due to covariates) are presented in Table 4.

Table 4

Marginal Means of Restricted and Idealized Sleep Groups from GLM Analyses with Baseline PANAS-C PA and NA, and STAIC A-State and A-Trait Scores Included Covariates

Variable	Restricted Sleep Mean (SE)	Idealized Sleep Mean (SE)	F-ratio	η^2	p
PANAS-C					
Time 2 PA	29.24 (1.64)	36.82 (1.64)	10.68*	.229	.002
Time 2 NA	17.36 (.50)	16.19 (.50)	2.69	.069	.110
STAIC					
Time 2 A-State	31.65 (.57)	26.98 (.57)	33.24***	.480	<.001
Time 2 A-Trait	30.62 (.55)	28.50 (.55)	7.49**	.172	.010

Note: PA = Positive Affect; NA = Negative Affect; A-State = State Anxiety; A-Trait = Trait Anxiety.

* $P < .05$, ** $P < .01$, *** $P < .001$

Emotional reactivity. In a multivariate GLM, the means from the SAM ratings (valence and intensity) for positive, neutral, negative, and reappraised negative picture types were compared between groups. There were a total of 8 dependent variables included in this analysis, as indicated in Table 5 (2 SAM dimensions x 4 Picture Types). Sleep condition was the between-subjects factor. The overall multivariate effect was not significant [$F(8, 33) = 0.842, \eta^2 = .170, p = .573$], indicating that groups did not differ in self-reported valence and arousal (i.e., emotional reactivity) in response to viewing positive, neutral, or negative images (including images which they had reappraised). Results are summarized in Table 5.

Table 5
Descriptive Means for Emotional Reactivity Variables

Dependent Variable	Overall Mean (SD)	Restricted Sleep Mean (SD)	Idealized Sleep Mean (SD)	F-ratio	η^2	p
<i>Valence</i>						
Positive Images	7.59 (0.84)	7.51 (0.68)	7.67 (0.98)	0.354	.009	.555
Neutral Images	5.10(0.38)	5.05 (0.32)	5.16 (0.44)	.911	.022	.345
Negative Images	3.06 (0.76)	2.84 (0.69)	3.27 (0.77)	3.721	.085	.061
Reappraised Negative Images	3.88 (1.18)	3.63 (1.16)	4.13 (1.17)	1.969	.047	.168
<i>Intensity</i>						
Positive Images	4.83 (2.06)	4.51 (1.87)	5.15 (2.24)	.999	.024	.323
Neutral Images	1.99 (1.22)	1.76 (0.85)	2.22 (1.49)	1.502	.036	.228
Negative Images	4.58 (1.69)	4.27 (1.81)	4.89 (1.54)	1.410	.034	.242
Reappraise Negative Images	4.27(1.68)	3.88 (1.71)	4.65 (1.60)	2.253	.053	.141

Note: Multivariate statistic was not significant; univariate statistics presented; Higher valence rating = greater positive valence; Higher intensity rating = greater intensity/arousal

Emotion regulation (cognitive reappraisal). In order to examine group differences in cognitive reappraisal, a GLM with sleep condition as the between-subjects factor and *Reappraisal Ability* and *Reappraisal Efficacy* scores as dependent variables

was conducted. The overall multivariate effect was non-significant [$F(2, 39) = 0.138$, $\eta^2 = .007$, $p = .872$], suggesting a lack of group differences on reappraisal variables.

However, cognitive reappraisal was found to effectively reduce negative valence ratings across groups (as indicated by the grand mean's confidence interval not including 0; C.I. = .505 - 1.142). Table 6 provides group means.

Table 6
Descriptive Means for Reappraisal Variables

Variable	Overall Mean (SD)	Restricted Sleep Mean (SD)	Idealized Sleep Mean (SD)	<i>F</i> -ratio	η^2	<i>p</i>
Reappraisal Ability	59.48 (10.48)	60.14 (10.76)	58.81 (10.41)	.166	.004	.685
Reappraisal Efficacy (Δ Valence Rating)	0.82 (1.01)	0.79 (0.99)	0.86 (1.05)	.046	.001	.832

Note: Multivariate statistic was not significant

Emotion regulation (cognitive reappraisal) as a mediator. In order to test the hypothesis that emotion regulation mediates the relationship between sleep condition and affective responses, bootstrap tests for indirect effects, as suggested by Preacher and Hayes (2008), were used. Importantly, the mediational effect can be tested even in the absence of a direct effect of X on Y (in this case, of sleep condition on affective responses; Hayes, 2009). This nonparametric method generates a distribution of the indirect effect by repeatedly and randomly selecting observations from the sample (with replacement) to generate new samples and then estimating the indirect effect for each of these samples. The indirect effect was then estimated based on its resulting distribution. 95% confidence intervals around the mean indirect effect were used to determine significance of mediation. Specifically, if the confidence interval did not contain 0, indirect effects (mediation) can be determined.

Four separate models were run, one each for the following dependent variables: PANAS-C PA, PANAS-C NA, STAIC A-State, and STAIC A-Trait. In each of these models, sleep condition was the IV, reappraisal variables (Reappraisal Ability and Reappraisal Efficacy) were tested as mediators, and the baseline equivalent of the DV was used as a covariate. None of the indirect effects were significant in any of the models, suggesting that emotion regulation, as assessed in the current study, did not mediate the effects of sleep condition on self-reported affect. Table 7 summarizes the models and their unstandardized regression coefficients, standard errors, and confidence intervals for indirect effects.

Table 7
Summary of Multiple Mediator Model Analyses

Model	Independent Variable (IV)	Mediator (M)	Dependent Variable (DV)	Indirect Effect b (SE)	95% CI
1	Sleep Condition	Reappraisal Ability	T2 PANAS-C PA	.168 (.601)	-.502-2.434
		Reappraisal Efficacy		.160 (.833)	-1.175-2.351
		TOTAL		.329 (.931)	-1.058-2.976
2	Sleep Condition	Reappraisal Ability	T2 PANAS-C NA	.053 (.182)	-.154-.744
		Reappraisal Efficacy		.011 (.139)	-.125-.500
		TOTAL		.065 (.216)	-.207-.859
3	Sleep Condition	Reappraisal Ability	T2 STAIC A-State	-.004 (.151)	-.375-.246
		Reappraisal Efficacy		.013 (.144)	-.118-.507
		TOTAL		.009 (.209)	-.364-.527
4	Sleep Condition	Reappraisal Ability	T2 STAIC A-Trait	.032 (.136)	-.124-.516
		Reappraisal Efficacy		.042 (.224)	-.370-.559
		TOTAL		.075 (.241)	-.364-.632

Note: T2= Time Point 2 (Post-Experimental). The following covariates were also included: Model 1- Time 1 PANAS-C PA; Model 2- Time 1 PANAS-C NA; Model 3-Time 1 STAIC A-State; Model 4- STAIC A-Trait.

Secondary Analyses

Sex differences. Sex was examined in relation to emotional reactivity in response to negative images. A multivariate GLM was conducted with negative image SAM ratings (valence and intensity) as dependent variables, both sex and sleep condition as between-subject factors in this analysis as well as their interaction. The overall multivariate effect for sex was non-significant [$F(2, 37) = 1.124, \eta^2 = .057, p = .336$], as was the multivariate effect for the interaction between sex and sleep condition [$F(2, 37) = 0.267, \eta^2 = .014, p = .767$].

In order to explore possible sex differences in emotion regulation variables, a multivariate GLM was conducted with both sex and sleep condition as between-subjects factors, the interaction between sleep condition and sex as an additional predictor, and reappraisal ability and efficacy as dependent variables. The overall multivariate effect of sex was not significant [$F(2, 37) = 0.531, \eta^2 = .028, p = .592$]. However, the multivariate effect for the interaction between sex and sleep condition was significant [$F(2, 37) = 3.645, \eta^2 = .165, p = .036$]. Follow-up univariate tests revealed the interaction for reappraisal ability [$F(1, 38) = 7.324, \eta^2 = .162, p = .010$], but not reappraisal efficacy [$F(1, 38) = 1.116, \eta^2 = .029, p = .297$] to be significant. However, further follow up tests did not reveal significant differences between females and males in reappraisal ability for either restricted or idealized sleep conditions. These results together suggest that sex was not associated with negative emotional reactivity or reappraisal variables for either restricted or idealized sleep groups.

Age differences. Potential age differences in emotion regulation were also explored. A multivariate GLM was conducted with sleep condition as the between-

subjects factor, age as an independent dimensional predictor, an interaction between age and sleep condition, and reappraisal ability and efficacy as dependent variables. The overall multivariate effect for age was not significant [$F(2, 37) = 0.530, \eta^2 = .028, p = .593$], and neither was the multivariate effect for the interaction between sleep condition and age [$F(2, 37) = 2.624, \eta^2 = .124, p = .086$]. This suggests that age was not associated with the ability to produce cognitive reappraisal statements or the effectiveness of using this strategy to down-regulate negative affect in response to threatening stimuli, regardless of sleep assignment.

Discussion

There remains a paucity of research examining the effects of sleep loss on affective functioning, particularly among adolescents, and existing research is limited in several ways. First, most research has been limited to correlational rather than experimental studies, which limits casually-driven hypothesis testing. Second, few studies have examined specific mechanisms through which sleep deprivation impacts changes in affect. To the best of our knowledge, no experimental studies have specifically examined emotion regulation as a potential mechanism of sleep-related affective change during the adolescent years. The current study utilized an experimental sleep paradigm with a sample of healthy adolescents to test the effects of sleep restriction (4 hours) relative to idealized sleep (9.5 hours) on acute affective responses, emotional reactivity, and emotion regulation. Notably, whereas previous research has primarily utilized one night of total sleep deprivation, the sleep manipulation used in this study more closely resembles the typical patterns of sleep loss experienced by adolescents.

Primary Aim 1: Effects of Sleep on Affect

Consistent with the study's hypotheses, partial sleep deprivation was associated with decreased self-reported positive affect and increased state anxiety. A finding of diminished positive affect after sleep loss corroborates results from other experimental sleep studies in adolescents and adults (e.g., Franzen et al., 2008; Talbot et al., 2010; McGlinchey et al., 2011). Talbot and colleagues (2010) utilized the same measure to assess positive affect (PANAS-C) and found similar results. Overall, consistent with existing literature, the present findings suggest that acute sleep deprivation in healthy adolescents results in negative affective changes primarily by decreasing levels of positive affect.

There may be several explanations for this effect. One possible reason for this finding may be that sleepiness and mood are interrelated (Woodson, 2006). Specifically, a state of feeling sleepy which is often unpleasant, may lead to a decreased experience of positive emotions. Woodson (2006) found that under normal sleeping conditions (i.e., lack of a sleep manipulation), sleepiness decreases receptivity to positive emotions. Sleepiness is therefore a potential mechanism through which sleep restriction exerts effects on positive affect. A noncompeting explanation, supported by research by Zohar et al. (2004), is that sleep loss reduces the positive effect of goal-enhancing events (e.g., unexpected opportunities to work towards a goal). This could be due to a diminished availability of cognitive-energy resources required to take advantage of opportunities that lead a specific goal (e.g., among medical residents, learning a new medical procedure) (Zohar et al., 2004). Therefore, when sleep restricted, adolescents may be less likely to experience increased positive emotions following otherwise beneficial events.

As expected, there were no group differences on a measure of global negative affect. That is, acute sleep restriction did not result in any significant changes in negative affect the next day relative to idealized sleep. This finding, coupled with a decrease in positive emotions might suggest that mood impairments associated with sleep loss could be more a function of anhedonia (i.e., impaired ability to experience pleasure from activities normally considered enjoyable) rather than increased experience of negative feelings. Within adolescent samples, a lack of change in negative affect following sleep restriction is consistent with results from some studies (Talbot et al., 2010; Dagys et al., 2012) but not others (Baum et al., 2014; McGlinchey et al., 2011). Results in adult samples are similarly equivocal (e.g., Dinges et al., 1997; Zohar et al., 2005; Franzen et al., 2008). There are several potential reasons for these discrepancies including contextual influences of affect. Among medical residents, Zohar and colleagues (2004) found that negative affect was not impacted by sleep loss in the absence of a goal-disruptive event (e.g., disruption in scheduled activity). However, they also found that negative affect was amplified by sleep loss when a disruptive event did occur. As the current study examined affect as part of a laboratory-based emotional processing battery, an ecologically-meaningful context was absent. Thus, while the current findings are important in suggesting that experience of negative emotions is not automatically increased after acute sleep restriction, it is possible that increases would occur in the context of a negative event.

In addition, the specific measure used to assess negative affect may to some extent explain mixed findings in the literature. More specifically, studies that have utilized the PANAS-C (e.g., Talbot et al., Dagys et al., 2012) have found no significant

effects of sleep restriction on negative affect, whereas studies that have used the Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1971) (e.g., Dinges et al., 1997) have found increases in negative affect. The mixed results reported by Franzen et al. (2009) lend support to this differentiation. In that study, both the PANAS (Watson, Clark, & Tellegen, 1988) and Visual Analogue Scale (VAS; Monk, 1989) scales were used. The VAS utilizes a visual analogue approach to measuring a broad dimension of negative affect (e.g., participants mark a tic along a continuous line). Franzen et al. (2008) found that sleep deprivation increased negative affect on the VAS but not on the PANAS. Overall, the current results are consistent with other studies using the PANAS (PANAS-C), but not with other measures used to measure negative affect.

It is important to highlight that the current study found a prominent floor effect for negative affect items on the PANAS-C, which could also explain these findings. So, while it was expected (and found) that negative affect would not significantly differ as a result of the sleep manipulation, it is possible that the non-significant effect observed is the result of measurement error. Ratings were highly skewed due to overall infrequent endorsement of negative emotions. In fact, all participants indicated a “1” (i.e., not much or not at all) for the items “frightened” and “afraid.” This floor effect makes sense given that the current sample consisted of healthy adolescents without significant levels of internalizing symptoms. This potential measurement artifact might also explain why the study found insufficient sleep to cause an increase in anxiety as measured by the STAIC but not relevant negative emotions of afraid, frightened, nervous, and scared on the PANAS-C. Other studies utilizing the PANAS/PANAS-C in an experimental sleep study similar to ours have also found this floor effect (Talbot et al., 2010; Franzen et al., 2008).

Overall, while it is premature to conclude that sleep restriction does not impact negative affect, convergent results across studies indicate positive affect to be most commonly impacted by sleep loss.

With regard to anxiety, adolescents who received only 4 hours of sleep reported being more anxious the next morning in comparison to those who had slept for 9.5 hours. This is consistent with other experimental studies among adolescents that have found an increase in state (transitory) anxiety as a result of sleep loss (Talbot et al., 2010; Baum et al., 2014); these findings have also been found in studies among adults (Vardar et al., 2007; Kahn-Greene et al., 2007; Sagaspe et al., 2006; Talbot et al., 2010). Thus, just one night of moderate sleep loss significantly increases anxiety. Although specific mechanisms require further investigation, it is possible that stress-related neurobehavioral effects resulting from sleep loss play a role (Dinges et al., 1997). Inadequate sleep places increased demands on an individual to stay awake, remain alert, retain attention/vigilance, and motivate. This would be particularly challenging in light of the increasing levels of sleepiness resulting from increased homeostatic sleep pressure, as well as impaired cognitive processes (c.f. Pilcher & Huffcut, 1996). These increased neurobehavioral demands may render adolescents more susceptible to the experience of anxiety and stress.

It is also possible that acute sleep loss leads to increased level of anxiety or stress directly through physiological processes. For example, partial sleep restriction has been found to acutely disrupt functioning of the hypothalamic-pituitary-adrenal (HPA) axis including negative glucocorticoid feedback regulation (Leproult, Copinschi, Buxton, & Van Cauter, 1997). Levels of cortisol, a major stress hormone, increase following periods

of sleep restriction/deprivation (Leproult, Copinschi, Buxton, & Van Cauter, 1997). Alterations in cardiac sympathovagal balance caused by sleep loss can also produce a stress response (c.f. Spiegel et al., 2004). Taken together, multiple processes spanning behavioral, cognitive, and physiological domains may explain elevated levels of anxiety or stress under conditions of inadequate sleep.

In terms of trait anxiety, in contrast to expectations, one night of sleep restriction resulted in increases in *trait* anxiety scores. This was unexpected as traits are considered relatively stable personality characteristics. There are several possible explanations for this finding. It is possible that adolescents' recall of their day-to-day anxiety may have been biased (e.g., more negative) after the sleep manipulation. This could be due to mood-dependent memory biases (Eich, Macaulay, & Ryan, 1994) on the retrieval of autobiographical events (e.g., being in an anxious momentary state may increase the likelihood of recalling more anxious events/responses). Due to availability heuristics, participants who readily recall such anxious events may conclude that they "generally" feel that way.

Increased trait anxiety also could reflect an expectancy effect (i.e., participants in the restricted sleep groups may have felt that they were expected to feel/report more anxiety based on their sleep assignment). The lack of control for expectancy effects in the current study precludes ruling this out as a possible explanation. It is also possible that the STAIC did not adequately discriminate between state and trait anxiety as this measure was originally developed for 9-12 year old children and a majority of research examining its psychometric properties has used child rather than adolescent samples (e.g., Dorr, 1981; Gaudry & Poole, 1975). It should nonetheless be noted that one other study did

find acute sleep loss to adversely affect trait-like anxiety. Kahn-Greene and colleagues (2007) found that healthy adults reported more anxiety on the Personality Assessment Inventory (PAI; Morey, 1991) after two nights of total sleep deprivation. The PAI is intended to measure personality traits (Morey, 1991) similar to the trait scale of the STAIC.

That sleep loss causes increases in anxiety among otherwise healthy adolescents is an important finding in light of the well-known link between poor sleep and anxiety among nonclinical populations of children (Alfano, Zakem, Costa, Taylor, & Weems, 2009) as well as youth with anxiety disorders (Alfano & Gamble, 2009). Inadequate/disrupted sleep is a robust risk factor for developing an anxiety disorder (and a range of other psychopathological disorders) across the life span (Ford & Kamerow, 1989; Gregory et al., 2005). Of particular relevance, longitudinal data show persistent sleep difficulties during childhood to predict the development of affective psychopathology in both adolescence and adulthood (Gregory & O'Connor, 2002; Gregory et al., 2005). As adolescence is a period of time during which sleep is generally insufficient (Carskadon, 1990), it is possible that prolonged periods of cumulative sleep loss leads to the subsequent development of anxiety disorders via increases in trait (stable) anxiety. Teenagers are also prone to experience affective disturbances due to heightened emotional arousability (often accompanying the onset of puberty) and difficulties with self-regulation of these emotions (Steinberg, 2005). Adolescents commonly choose ineffective regulation strategies, such as denial, avoidance, rumination and impulsivity, which are associated with negative affective states and/or behavioral

problems (Silk, Steinberg, & Morris, 2003). These collective factors place adolescents at risk for the development of psychiatric disorders.

Primary Aim 2: Effects of Sleep on Emotional Reactivity

In the present study, emotional reactivity was examined using the Self-Assessment Manikin (SAM) arousal and valence ratings (Bradley & Lang, 1994) in response to picture stimuli from the International Affective Picture System (IAPS; Lang et al., 2008). It is important to note that although emotions can span experiential, behavioral, and physiological domains (Gross, 2002), the current study focused on the experiential aspect of emotional reactivity, which was assessed through self-report.

The current study hypothesized that emotional reactivity (both valence and intensity/arousal ratings) in response to negative images would be greater in sleep-restricted adolescents relative to those in the idealized sleep group. We failed to find significant differences in reactivity for negative images between the groups, although the group difference in valence ratings for negative images did show a trend toward significance ($p=.061$) in the hypothesized direction (e.g., sleep restricted teens rated these images more negatively); however, in the absence of the overall group effect, the meaning of this result is unclear. Thus, we did not find clear support of a negative emotional bias (Tempesta et al., 2010). In addition, there were no differences between the sleep restricted and idealized groups with respect to emotional reactivity to neutral or positive picture stimuli, which is consistent with prior research (Leotta et al., 1997; Franzen, et al., 2009). Overall this suggests that among healthy adolescents, one night of partial sleep restriction (following one week of at least seven hours of sleep) does not

meaningfully impact subjective emotional reactivity to emotionally-evocative or neutral stimuli.

It would be worthwhile to concurrently examine reactivity assessed via behavioral and physiological domains given that these reactions do not necessarily correspond to one another according to the “Modal Model” of emotion (Gross & Thompson, 2007). Support for this possibility comes from research by Yoo and colleagues (2007) who observed neurological evidence of enhanced reactivity to negative stimuli after 35 hours of sleep deprivation. Specifically, negative stimuli triggered greater amygdala reactivity and reduced functional connectivity between the amygdala and medial prefrontal cortex (mPFC) regions. It is therefore possible that although subjective experience of reactivity may not increase following sleep loss, physiological increases in reactivity may still be affected.

Primary Aims 3-4: (3) Effects of Sleep on Emotion Regulation, (4) Emotion Regulation as Mediator of Sleep Condition and Affect

The current study also examined the extent to which adolescents in the restricted sleep group would demonstrate impaired emotion regulation in response to negative stimuli from the IAPS relative to those in the idealized sleep condition. According to Gross’s “Process Model of Emotion Regulation” (Gross & Thompson, 2007), there are five different points at which emotion regulation can impact the emotion-generative process (see Figure 2). The current study focused on the fourth point, cognitive change, which involves re-appraising a given situation, often with the aim to decrease the experience of negative emotions. Cognitive change (reappraisal) was assessed in two ways: 1) the ability to produce reappraisal statements to threatening images (reappraisal

ability) and 2) the efficacy of these reappraisals in down-regulating negative emotions (reappraisal efficacy). It was hypothesized that restricted sleep would result in both decreased reappraisal ability and efficacy.

Hypotheses were not supported by the data. Specifically, there were no group differences in cognitive reappraisal strategies. Both sleep groups evidenced similar reappraisal ability and use of cognitive reappraisal techniques was equally successful in down-regulating negative emotions in both sleep groups. The latter set of results might be expected in light of similar IAPS ratings of arousal and valence for both appraised and reappraised negative images between the groups. The hypothesis that emotion regulatory variables would mediate the effects of sleep condition on affective functioning (positive and negative affect, state and trait anxiety) also was not supported. Again, this finding is not surprising based on the lack of group differences on emotional reactivity and regulatory variables.

Although the current study did not find the ability to use or effectiveness of cognitive reappraisals to differ between the two sleep groups, the finding that a reappraisal strategy was successful in altering affect (in all youth) replicates other research (Carthy et al., 2009; McRae et al., 2012; Ochsner et al., 2004). Nonetheless, the lack of group-based differences in the current study was somewhat surprising given that cognitive abilities required to reappraise (e.g., attention, working memory) (Kalisch, 2009; Ochsner & Gross, 2008) are adversely impacted by sleep loss (Steenari et al., 2002; Pilcher & Huffcut, 1996). It is possible that the ability to come up with alternative explanations/perceptions is resistant to moderate sleep loss. These findings are inconsistent with those by Baum et al. (2014), who found that adolescents getting 6.5

hours of sleep a night for 5 consecutive nights evidenced more emotion regulation difficulties in comparison to a healthy-sleep group that slept for 10 hours for 5 nights. It may be that one night of sleep restriction was not sufficient to impact emotion regulation. Alternatively, differences may be due to the operationalization of emotion regulation difficulties between studies. The study by Baum et al. (2014) measured emotion regulation difficulties through parent and adolescent responses to three questions on a questionnaire pertaining to the extent to which the adolescent got upset, whether the emotional reaction was unprovoked, or whether it was considered to be disproportionately large (Baum et al., 2014). It is possible then, that perception or recall of emotion regulation rather than actual ability may be more adversely impacted by sleep loss.

Although our assessment of emotion regulation was more objective than has been used in previous studies, it is possible that, in the context of Gross's "Process Model of Emotion Regulation" (Gross & Thompson, 2007), emotion regulatory strategies used at different points in the timeline of emotion generation, could be differentially impacted by sleep loss. For example, other antecedent-focused strategies (situation selection, situation modification, and attentional deployment) that can occur prior to cognitive reappraisal may be more effective tools for regulating emotions during adolescence. Another possibility is that response-focused strategies (emotion regulatory strategies that occur *after* an emotion is already underway) may be more affected by sleep restriction. One example of a response-focused strategy that warrants examination is suppression, or hiding evident signs of emotions through limiting facial expressions or vocal cues. There is indeed evidence to suggest that reappraisal and suppression emotion regulatory

strategies differentially impact emotional experience (Goldin, McRae, Ramel, & Gross, 2008). Experimental investigation that concurrently examines antecedent and response focused emotion regulatory strategies will help determine at which points of the emotion-generative process, if any, emotion regulatory strategies are impacted by sleep, and contribute to changes in the emotional responses. Overall, further research is needed to elucidate the mechanisms of emotional disturbance caused by sleep, especially in the context of alternative emotion regulatory strategies.

A few other caveats should be mentioned regarding findings for emotion regulation. As the cognitive reappraisal task took place in the laboratory setting, it has limitations in terms of its ecological validity, as participants may respond differently in a more naturalistic environment. Moreover, as the task involved stimuli that likely did not have much personal relevance for participants, it may have required less emotional and more controlled, higher order functions. It is also important to note that research staff specifically taught participants how to use cognitive reappraisals prior to the IAPS task and explicitly asked them to apply this strategy towards images. Therefore, we did not assess their natural, spontaneous use of cognitive reappraisal skills. Cued versus spontaneous use of this strategy may be differentially affected by sleep loss. For example, in the face of emotional “triggers” of personal relevance (e.g., argument with a peer), cognitive reappraisals may be less effective in down-regulating negative emotions in this more natural context. Another potential limitation is that because research staff taught the reappraisal strategy prior to viewing or rating any of the images, adolescents may have used this strategy, to some extent, when viewing *all* images. The timing of the training therefore could potentially have inadvertently impacted results.

Secondary Aims: Age and Sex

The current study also examined the roles of age and sex. The hypothesis that age would be positively associated with higher reappraisal ability and effectiveness was not supported in either sleep group. This finding is inconsistent with research that has shown that younger adolescents report using reappraisal strategies less frequently than do older adolescents or adults (Garnefski & Kraaij, 2006), which could be due to continued cognitive development and associated increases in white matter across brain regions (Steinberg, 2005; Giedd et al., 1999; Lenroot & Giedd, 2006). It is possible that even young adolescents in the sample have developed the cognitive capabilities necessary to utilize reappraisal strategies when prompted. As the current study included a relatively small sample and narrow range with respect to age (13-17 years of age), we may have been unable to detect developmental differences in this skill (McRae et al., 2012). Expanding the sample to include older children and young adults would allow for age-related effects to be more adequately assessed.

Additionally, the current study hypothesized that there would be sex differences in subjective emotional reactivity and emotion regulation such that females would report higher intensity of emotional reactivity to negative stimuli and higher reappraisal ability and efficacy regardless of sleep condition. These hypotheses also were not supported. More specifically, there were no differences between males and females in their level of reactivity to negative pictures, ability to generate reappraisal statements, or in efficacy in decreasing negative emotions via cognitive reappraisals, both while their sleep was restricted and idealized. Prior research in adults (e.g., van der Helm et al., 2010) has found females to evidence increased reactivity to negative stimuli, especially when sleep

restricted. It is possible that sex differences in reactivity emerge after the mid-adolescence time period, thereby explaining the discrepancies between the current findings and studies conducted with adults. Alternatively, it is possible that the reappraisal task used did not allow for detection of a gender effect.

The finding regarding a lack of sex differences in reappraisals was also unexpected. Although males (both adult and youth) report less use of reappraisals in their daily lives in comparison to females (Gullone et al., 2010), findings from the current study suggest that males and females may be equally capable of using this emotion regulation strategy when prompted. This would suggest that skill in reappraising events is equally developed between adolescent males and females. Due to the use of only self-report for assessing reappraisal efficacy, it is also possible that while self-perception of down-regulating negative emotions does not differ, accompanying physiologic indices do. McRae and colleagues (2008) for example, found that while self-reported regulation did not differ between males and females, concurrent assessment via functional resonance imaging found that females evidenced less regulation. Further multi-method assessments utilizing both subjective and objective indices of reactivity and regulation is therefore required.

Implications for Treatment

Findings from the current study have several clinical implications. The current study found that sleep loss causes increased anxiety and decreased positive affect. This highlights the need for adequate sleep particularly for those who may be genetically predisposed or otherwise prone to developing an anxiety disorder or a depressive episode (as depression is characterized by decreased positive affect; Watson & Clark, 1991).

Treatments for adolescents (a chronically sleep deprived group) with disorders related to anxiety/and or mood might consider the inclusion of a sleep component (e.g., psycho-education on sleep, sleep hygiene). Additionally, collecting information about current sleep habits and duration during an initial intake assessment may be beneficial. Treatment research studies for youth that include a sleep intervention are steadily growing, and have found improvements on anxiety (e.g., Paine & Gradisar, 2011; Clementi & Alfano, 2014).

The success of the cognitive reappraisal task used in the current study, which was effective for both groups, also has implications for the treatment of affective disorders. Cognitive reappraisal is a core technique implemented in cognitive and cognitive-behavioral treatments. Findings from this study suggest that this technique can be used effectively in adolescents, irrespective of exact age or gender, to down-regulate negative emotions.

Additional Limitations

Despite the contribution of new findings, there are several limitations of this study that should be noted. As the current sample consisted of only healthy adolescents who have been screened for psychiatric, sleep, and some medical disorders, findings cannot readily be generalized to other (e.g., clinical) samples. Research has shown that the effects of sleep loss may be different for those who have a clinical affective presentation. For example, research has shown that sleep deprivation in people who are bipolar depressed can induce a “switch” to a manic or hypomanic episode (Colombo, Benedetti, Barbini, Campori, & Smeraldi, 1998; Giedke & Schwarzler, 2002). Among patients who are prone to depressive episodes, sleep deprivation can have a prophylactic effect

(Giedke & Schwarzler, 2002) and among people who are already depressed, sleep (restriction) deprivation can lead to a remission in symptoms (Giedke & Schwarzler, 2002), including for those who are bipolar depressed (Benedetti et al., 2007). There is also some evidence to suggest that sleep deprivation can reduce the development of posttraumatic stress disorder (PTSD) for people who have been exposed to a traumatic event (Kuriyama, Soshi, & Kim, 2010). Thus, it is possible that the results and implications of sleep restriction may differ for clinical samples, and that sleep restriction may have therapeutic benefits when done in a controlled manner.

Additionally, it should be noted that a number of families who initially expressed interest in the study declined to participate due to concerns about the adolescent meeting the requirement to attain at least 7 hours of sleep each night during the baseline period. Several parents believed that this requirement was not possible given their teens' demanding academic and extracurricular schedules. This concern was especially prevalent among adolescents involved in athletics and reflects a common problem among teenagers. It is therefore possible that our sample is not adequately representative of many adolescents.

In addition to concerns regarding generalizability of results, another limitation is the relatively small sample size in the current study. It is possible that the low sample size could have provided inadequate power to detect otherwise significant effects. Several other studies have attempted to address this issue in sleep manipulation studies by using within-subjects, cross-over designs. The current study instead used a between-subjects design due to concerns of learning effects on the cognitive reappraisal task. Future studies using alternative designs and larger samples are needed.

A possible threat to the internal validity relates to possible expectancy effects. That is, reported changes in positive affect and anxiety found in the sleep restricted group may at least partially be attributable to what participants felt they were *expected* to experience. There are at least three different ways that a future study could address this limitation. One, experimenters can withhold from participants the true aim of the study. For example, participants could be informed that the study was interested in the effects of sleep on performance on a math task. Two, expectancy effects can be examined by including a measure that is not expected to be different between sleep condition groups. For example, Baum et al. (2014) assessed for expectancy effects this way by including a measure of hyperactivity/impulsivity, which they predicted would not be different between sleep restricted and healthy duration sleep conditions. Three, the inclusion of objective indices could also minimize expectancy effects. This would include measures like pupil diameter indices or brain imaging, as previously discussed.

Several methodological factors may also limit interpretation of findings relevant to emotional reactivity and regulation. It is possible that the negative IAPS images used in the study may not have been evocative enough to elicit the negative emotions that were anticipated among adolescents. Although the images covered negative themes (e.g., disasters, violence, etc.), none of the images included gore, mutilation, or anything deemed too controversial. Given that most teenagers are often exposed to graphic images in movies and videogames, it is possible that they were somewhat desensitized to image content. The images used by McRae and colleagues (2012) to assess cognitive reappraisal amongst adolescents were more graphic and intense. Inclusion of more threatening stimuli (either images with more negative valence, or a video) may elicit stronger

negative reactions that then have more potential to be down-regulated. In other words, if the images were not perceived to be that threatening in the first place, then there may not be as much content to reappraise. In addition, the higher proportion of negative images in the study (relative to positive or neutral images), may have resulted in some level of habituation for this image type.

Finally, although this study attempted to understand adolescents' daily sleep related habits (e.g., what they did right before going to bed, consumption of caffeine through the day), the current study found that much of this information was not useable due to concerns about accuracy of participants' reports. In some cases it was evident that teens had filled out the sleep diary and all related information on the day of the evaluation. Although actigraphy provided reliable assessment of sleep, the extent to which the results were impacted by routine caffeine use and/or physical activity is unknown and remains a question for future research.

Conclusion

This study was among a small number of studies to examine the effects of experimental sleep loss on both affect and emotion regulation in healthy adolescents using a one-night sleep restriction paradigm. Results suggest that just one night of modest sleep restriction sleep has adverse effects on positive affect and anxiety. A lack of effect on emotional reactivity and emotion regulation in response to emotionally-evocative and neutral stimuli may relate to the exact sleep manipulation used, the emotional stimuli/tasks employed, or chosen assessment measures. Alternatively, these domains of emotional processing may only be mildly impacted by sleep loss. Overall, findings add to a growing body of research suggesting the deleterious effects of sleep loss on affective

functioning among healthy adolescents. Future research should replicate and elucidate the specific mechanisms of these effects.

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Appendix A

General Information Sheet
(Parent measure administered at first visit)

ID# _____

Today's Date _____

Sleep and Emotions in Adolescents

General Information Sheet

1) Child's Gender: Male Female

2) Child's Date of Birth: mm/dd/yyyy _____

3) Child's Age _____

3) What is your relationship to the Child?

_____ Biological Mother

_____ Biological Father

____ Adoptive Mother

____ Adoptive Father

Grandparent

Other _____

4) What is your Date of Birth? mm/dd/yyyy _____

5) Your Age _____

6) Please list all the people who live in your home?

Relationship	Age
--------------	-----

ID# _____

Today's Date _____

7) What is your marital status?

- _____ Married to child's father/mother
- _____ Married to another partner
- _____ Single
- _____ Divorced
- _____ Separated
- _____ Widowed

8) Family ethnicity/race: (e.g., Caucasian, African-American, Asian, Latino/a, etc.)

Mother _____
Father _____
Child _____

9) Mother's Highest Level of Education:

- _____ Some grade school
- _____ High School Degree
- _____ Some College
- _____ College Degree
- _____ Advanced Degree _____

10) Father's Highest Level of Education:

- _____ Some grade school
- _____ High School Degree
- _____ Some College
- _____ College Degree
- _____ Advanced Degree _____

11) Present Household Income:

- _____ less than \$10,000
- _____ \$10,000 to \$20,000
- _____ \$20,000 to \$40,000
- _____ \$40,000 to \$60,000
- _____ \$60,000 to \$80,000
- _____ \$80,000 to \$100,000
- _____ more than \$100,000

12) What type of classroom/school does your child currently attend?

- _____ Regular/Mainstream
- _____ Special Education
- _____ Gifted/Talented
- _____ Homeschooled
- _____ Other: Describe _____

ID# _____

Today's Date _____

13) Has your child ever: (check all that apply)

- _____ repeated a grade
 _____ skipped a grade
 _____ been suspended or expelled

14) At what age was your child born: _____ weeks**15) At what age did your child first:**

- Sleep thru the night _____ months
 Walk _____ months
 Talk _____ months
 Use the toilet _____ months

16) Does your child have any current medical problems or diagnoses? Yes No

Please describe: _____

17) Has your child had any previous medical problems or diagnoses? Yes No

Please describe: _____

17) Does your child currently take any medications currently? Yes No

If yes, please list medications and reasons for each:

Medication Name & Dosage**Reason**

Revised Children's Anxiety and Depression Scale, Parent Report
(Parent measure administered at first visit)

Date: _____

RCADS-P

Name/ID: _____

Relationship to Child: _____

Please put a circle around the word that shows how often each of these things happens for your child.

1. My child worries about things	Never	Sometimes	Often	Always
2. My child feels sad or empty	Never	Sometimes	Often	Always
3. When my child has a problem, he/she gets a funny feeling in his/her stomach	Never	Sometimes	Often	Always
4. My child worries when he/she thinks he/she has done poorly at something	Never	Sometimes	Often	Always
5. My child feels afraid of being alone at home	Never	Sometimes	Often	Always
6. Nothing is much fun for my child anymore	Never	Sometimes	Often	Always
7. My child feels scared when taking a test	Never	Sometimes	Often	Always
8. My child worries when he/she thinks someone is angry with him/her.	Never	Sometimes	Often	Always
9. My child worries about being away from me	Never	Sometimes	Often	Always
10. My child is bothered by bad or silly thoughts or pictures in his/her mind	Never	Sometimes	Often	Always
11. My child has trouble sleeping	Never	Sometimes	Often	Always
12. My child worries about doing badly at school work	Never	Sometimes	Often	Always
13. My child worries that something awful will happen to someone in the family	Never	Sometimes	Often	Always
14. My child suddenly feels as if he/she can't breathe when there is no reason for this.	Never	Sometimes	Often	Always
15. My child has problems with his/her appetite	Never	Sometimes	Often	Always
16. My child has to keep checking that he/she has done things right (like the switch is off, or the door is locked)	Never	Sometimes	Often	Always
17. My child feels scared to sleep on his/her own	Never	Sometimes	Often	Always
18. My child has trouble going to school in the mornings because of feeling nervous or afraid.	Never	Sometimes	Often	Always
19. My child has no energy for things	Never	Sometimes	Often	Always
20. My child worries about looking foolish	Never	Sometimes	Often	Always
21. My child is tired a lot	Never	Sometimes	Often	Always
22. My child worries that bad things will happen to him/her	Never	Sometimes	Often	Always
23. My child can't seem to get bad or silly thoughts out of his/her head.	Never	Sometimes	Often	Always

24. When my child has a problem, his/her heart beats really fast	Never	Sometimes	Often	Always
25. My child cannot think clearly	Never	Sometimes	Often	Always
26. My child suddenly starts to tremble or shake when there is no reason for this	Never	Sometimes	Often	Always
27. My child worries that something bad will happen to him/her	Never	Sometimes	Often	Always
28. When My child has a problem, he/she feels shaky	Never	Sometimes	Often	Always
29. My child feels worthless	Never	Sometimes	Often	Always
30. My child worries about making mistakes	Never	Sometimes	Often	Always
31. My child has to think of special thoughts (like numbers or words) to stop bad things from happening	Never	Sometimes	Often	Always
32. My child worries what other people think of him/her	Never	Sometimes	Often	Always
33. My child is afraid of being in crowded places (like shopping centers, the movies, buses, busy playgrounds)	Never	Sometimes	Often	Always
34. All of a sudden my child will feel really scared for no reason at all	Never	Sometimes	Often	Always
35. My child worries about what is going to happen	Never	Sometimes	Often	Always
36. My child suddenly becomes dizzy or faint when there is no reason for this	Never	Sometimes	Often	Always
37. My child thinks about death	Never	Sometimes	Often	Always
38. My child feels afraid if he/she have to talk in front of the class	Never	Sometimes	Often	Always
39. My child's heart suddenly starts to beat too quickly for no reason	Never	Sometimes	Often	Always
40. My child feels like he/she doesn't want to move	Never	Sometimes	Often	Always
41. My child worries that he/she will suddenly get a scared feeling when there is nothing to be afraid of	Never	Sometimes	Often	Always
42. My child has to do some things over and over again (like washing hands, cleaning, or putting things in a certain order)	Never	Sometimes	Often	Always
43. My child feels afraid that he/she will make a fool of him/herself in front of people	Never	Sometimes	Often	Always
44. My child has to do some things in just the right way to stop bad things from happening	Never	Sometimes	Often	Always
45. My child worries when in bed at night	Never	Sometimes	Often	Always
46. My child would feel scared if he/she had to stay away from home overnight	Never	Sometimes	Often	Always
47. My child feels restless	Never	Sometimes	Often	Always

Child Behavior Checklist for Ages 6-18 (CBCL)
(Parent measure administered at first visit)

Please print. Be sure to answer all items.

Below is a list of items that describe children and youths. For each item that describes your child **now or within the past 6 months**, please circle the **2** if the item is **very true or often true** of your child. Circle the **1** if the item is **somewhat or sometimes true** of your child. If the item is **not true** of your child, circle the **0**. Please answer all items as well as you can, even if some do not seem to apply to your child.

0 = Not True (as far as you know)			1 = Somewhat or Sometimes True			2 = Very True or Often True		
0	1	2	1. Acts too young for his/her age	0	1	2	32. Feels he/she has to be perfect	
0	1	2	2. Drinks alcohol without parents' approval (describe): _____	0	1	2	33. Feels or complains that no one loves him/her	
0	1	2	3. Argues a lot	0	1	2	34. Feels others are out to get him/her	
0	1	2	4. Fails to finish things he/she starts	0	1	2	35. Feels worthless or inferior	
0	1	2	5. There is very little he/she enjoys	0	1	2	36. Gets hurt a lot, accident-prone	
0	1	2	6. Bowel movements outside toilet	0	1	2	37. Gets in many fights	
0	1	2	7. Bragging, boasting	0	1	2	38. Gets teased a lot	
0	1	2	8. Can't concentrate, can't pay attention for long	0	1	2	39. Hangs around with others who get in trouble	
0	1	2	9. Can't get his/her mind off certain thoughts; obsessions (describe): _____	0	1	2	40. Hears sounds or voices that aren't there (describe): _____	
0	1	2	10. Can't sit still, restless, or hyperactive	0	1	2	41. Impulsive or acts without thinking	
0	1	2	11. Clings to adults or too dependent	0	1	2	42. Would rather be alone than with others	
0	1	2	12. Complains of loneliness	0	1	2	43. Lying or cheating	
0	1	2	13. Confused or seems to be in a fog	0	1	2	44. Bites fingernails	
0	1	2	14. Cries a lot	0	1	2	45. Nervous, highstrung, or tense	
0	1	2	15. Cruel to animals	0	1	2	46. Nervous movements or twitching (describe): _____	
0	1	2	16. Cruelty, bullying, or meanness to others	0	1	2	47. Nightmares	
0	1	2	17. Daydreams or gets lost in his/her thoughts	0	1	2	48. Not liked by other kids	
0	1	2	18. Deliberately harms self or attempts suicide	0	1	2	49. Constipated, doesn't move bowels	
0	1	2	19. Demands a lot of attention	0	1	2	50. Too fearful or anxious	
0	1	2	20. Destroys his/her own things	0	1	2	51. Feels dizzy or lightheaded	
0	1	2	21. Destroys things belonging to his/her family or others	0	1	2	52. Feels too guilty	
0	1	2	22. Disobedient at home	0	1	2	53. Overeating	
0	1	2	23. Disobedient at school	0	1	2	54. Overtired without good reason	
0	1	2	24. Doesn't eat well	0	1	2	55. Overweight	
0	1	2	25. Doesn't get along with other kids	0	1	2	56. Physical problems without known medical cause :	
0	1	2	26. Doesn't seem to feel guilty after misbehaving	0	1	2	a. Aches or pains (not stomach or headaches)	
0	1	2	27. Easily jealous	0	1	2	b. Headaches	
0	1	2	28. Breaks rules at home, school, or elsewhere	0	1	2	c. Nausea, feels sick	
0	1	2	29. Fears certain animals, situations, or places, other than school (describe): _____	0	1	2	d. Problems with eyes (not if corrected by glasses) (describe): _____	
0	1	2	30. Fears going to school	0	1	2	e. Rashes or other skin problems	
0	1	2	31. Fears he/she might think or do something bad	0	1	2	f. Stomachaches	
				0	1	2	g. Vomiting, throwing up	
				0	1	2	h. Other (describe): _____	

PAGE 3 **Be sure you answered all items. Then see other side.**

Please print. Be sure to answer all items.

0 = Not True (as far as you know)			1 = Somewhat or Sometimes True			2 = Very True or Often True		
0	1	2	57. Physically attacks people	0	1	2	84. Strange behavior (describe): _____	
0	1	2	58. Picks nose, skin, or other parts of body (describe): _____	0	1	2	85. Strange ideas (describe): _____	
0	1	2	59. Plays with own sex parts in public	0	1	2	86. Stubborn, sullen, or irritable	
0	1	2	60. Plays with own sex parts too much	0	1	2	87. Sudden changes in mood or feelings	
0	1	2	61. Poor school work	0	1	2	88. Sulks a lot	
0	1	2	62. Poorly coordinated or clumsy	0	1	2	89. Suspicious	
0	1	2	63. Prefers being with older kids	0	1	2	90. Swearing or obscene language	
0	1	2	64. Prefers being with younger kids	0	1	2	91. Talks about killing self	
0	1	2	65. Refuses to talk	0	1	2	92. Talks or walks in sleep (describe): _____	
0	1	2	66. Repeats certain acts over and over; compulsions (describe): _____	0	1	2	93. Talks too much	
0	1	2	67. Runs away from home	0	1	2	94. Teases a lot	
0	1	2	68. Screams a lot	0	1	2	95. Temper tantrums or hot temper	
0	1	2	69. Secretive, keeps things to self	0	1	2	96. Thinks about sex too much	
0	1	2	70. Sees things that aren't there (describe): _____	0	1	2	97. Threatens people	
0	1	2	71. Self-conscious or easily embarrassed	0	1	2	98. Thumb-sucking	
0	1	2	72. Sets fires	0	1	2	99. Smokes, chews, or sniffs tobacco	
0	1	2	73. Sexual problems (describe): _____	0	1	2	100. Trouble sleeping (describe): _____	
0	1	2	74. Showing off or clowning	0	1	2	101. Truancy, skips school	
0	1	2	75. Too shy or timid	0	1	2	102. Underactive, slow moving, or lacks energy	
0	1	2	76. Sleeps less than most kids	0	1	2	103. Unhappy, sad, or depressed	
0	1	2	77. Sleeps more than most kids during day and/or night (describe): _____	0	1	2	104. Unusually loud	
0	1	2	78. Inattentive or easily distracted	0	1	2	105. Uses drugs for nonmedical purposes (<i>don't</i> include alcohol or tobacco) (describe): _____	
0	1	2	79. Speech problem (describe): _____	0	1	2	106. Vandalism	
0	1	2	80. Stares blankly	0	1	2	107. Wets self during the day	
0	1	2	81. Steals at home	0	1	2	108. Wets the bed	
0	1	2	82. Steals outside the home	0	1	2	109. Whining	
0	1	2	83. Stores up too many things he/she doesn't need (describe): _____	0	1	2	110. Wishes to be of opposite sex	
				0	1	2	111. Withdrawn, doesn't get involved with others	
				0	1	2	112. Worries	
				0	1	2	113. Please write in any problems your child has that were not listed above:	
				0	1	2	_____	
				0	1	2	_____	
				0	1	2	_____	

PAGE 4

Please be sure you answered all items.

Children's Sleep Habits Questionnaire
(Parent measure administered at first visit)

Child's Sleep Habits
(Preschool and School-Aged)
(Abbreviated Version)

Coding

The following statements are about your child's sleep habits and possible difficulties with sleep. Think about the past week in your child's life when answering the questions. If last week was unusual for a specific reason (such as your child had an ear infection and did not sleep well or the TV set was broken), choose the most recent typical week. Answer USUALLY if something occurs 5 or more times in a week; answer SOMETIMES if it occurs 2-4 times in a week; answer RARELY if something occurs never or 1 time during a week. Also, please indicate whether or not the sleep habit is a problem by circling "Yes," "No," or "Not applicable (N/A)".

Bedtime

Write in child's bedtime: _____

	3 Usually (5-7)	2 Sometimes (2-4)	1 Rarely (0-1)	Problem?		
1) Child goes to bed at the same time at night (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
2) Child falls asleep within 20 minutes after going to bed (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
3) Child falls asleep alone in own bed (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
4) Child falls asleep in parent's or sibling's bed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
5) Child needs parent in the room to fall asleep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
6) Child struggles at bedtime (cries, refuses to stay in bed, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
7) Child is afraid of sleeping in the dark	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
8) Child is afraid of sleeping alone	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A

Sleep Behavior

Child's usual amount of sleep each day: _____ hours and _____ minutes
(combining nighttime sleep and naps)

	3 Usually (5-7)	2 Sometimes (2-4)	1 Rarely (0-1)	Problem?		
9) Child sleeps too little	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
10) Child sleeps the right amount (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
11) Child sleeps about the same amount each day (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
12) Child wets the bed at night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
13) Child talks during sleep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
14) Child is restless and moves a lot during sleep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
15) Child sleepwalks during the night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
16) Child moves to someone else's bed during the night (parent, brother, sister, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
17) Child grinds teeth during sleep (your dentist may have told you this)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
18) Child snores loudly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A

Coding

Sleep Behavior (continued)

	3 Usually (5-7)	2 Sometimes (2-4)	1 Rarely (0-1)	Problem?		
19) Child seems to stop breathing during sleep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
20) Child snorts and/or gasps during sleep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
21) Child has trouble sleeping away from home (visiting relatives, vacation)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
22) Child awakens during night screaming, sweating, and inconsolable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
23) Child awakens alarmed by a frightening dream	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A

Waking During the Night

	3 Usually (5-7)	2 Sometimes (2-4)	1 Rarely (0-1)	Problem?		
24) Child awakes once during the night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
25) Child awakes more than once during the night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A

Write the number of minutes a night waking usually lasts: _____

Morning Waking/Daytime Sleepiness

Write in the time of day child usually wakes in the morning: _____

	3 Usually (5-7)	2 Sometimes (2-4)	1 Rarely (0-1)	Problem?		
26) Child wakes up by him/herself (R)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
27) Child wakes up in negative mood	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
28) Adults or siblings wake up child	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
29) Child has difficulty getting out of bed in the morning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
30) Child takes a long time to become alert in the morning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A
31) Child seems tired	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Yes	No	N/A

Child has appeared very sleepy or fallen asleep during the following (check all that apply):

	1 Not Sleepy	2 Very Sleepy	3 Falls Asleep
32) Watching TV	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
33) Riding in car	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Daily Sleep Diary
(Child record kept during baseline week)

National Sleep Foundation Sleep Diary												
Fill out days 1-4 below and days 5-7 on page 2	COMPLETE IN MORNING							COMPLETE AT END OF DAY				
	I went to bed last night at:	I got out of bed this morning at:	Last night, I fell asleep in:	I woke up during the night:	When I woke up for the day, I felt:	Last night I slept a total of:	My sleep was disturbed by:	I consumed caffeinated drinks in the:	I exercised at least 20 minutes in the:	Approximately 2-3 hours before going to bed, I consumed:	Medication(s) I took during the day:	About 1 hour before going to sleep, I did the following activity:
DAY 1 DAY _____ DATE _____	____ PM/AM	____ PM/AM	____ Minutes	____ Times	<input type="checkbox"/> Refreshed <input type="checkbox"/> Somewhat refreshed <input type="checkbox"/> Fatigued	____ Hours	_____ _____ _____ _____	<input type="checkbox"/> Morning <input type="checkbox"/> Afternoon <input type="checkbox"/> Within several hours before going to bed <input type="checkbox"/> Not applicable	<input type="checkbox"/> Morning <input type="checkbox"/> Afternoon <input type="checkbox"/> Within several hours before going to bed <input type="checkbox"/> Not applicable	<input type="checkbox"/> Alcohol <input type="checkbox"/> A heavy meal <input type="checkbox"/> Not applicable	_____	_____
DAY 2 DAY _____ DATE _____	____ PM/AM	____ PM/AM	____ Minutes	____ Times	<input type="checkbox"/> Refreshed <input type="checkbox"/> Somewhat refreshed <input type="checkbox"/> Fatigued	____ Hours	_____ _____ _____ _____	<input type="checkbox"/> Morning <input type="checkbox"/> Afternoon <input type="checkbox"/> Within several hours before going to bed <input type="checkbox"/> Not applicable	<input type="checkbox"/> Morning <input type="checkbox"/> Afternoon <input type="checkbox"/> Within several hours before going to bed <input type="checkbox"/> Not applicable	<input type="checkbox"/> Alcohol <input type="checkbox"/> A heavy meal <input type="checkbox"/> Not applicable	_____	_____
DAY 3 DAY _____ DATE _____	____ PM/AM	____ PM/AM	____ Minutes	____ Times	<input type="checkbox"/> Refreshed <input type="checkbox"/> Somewhat refreshed <input type="checkbox"/> Fatigued	____ Hours	_____ _____ _____ _____	<input type="checkbox"/> Morning <input type="checkbox"/> Afternoon <input type="checkbox"/> Within several hours before going to bed <input type="checkbox"/> Not applicable	<input type="checkbox"/> Morning <input type="checkbox"/> Afternoon <input type="checkbox"/> Within several hours before going to bed <input type="checkbox"/> Not applicable	<input type="checkbox"/> Alcohol <input type="checkbox"/> A heavy meal <input type="checkbox"/> Not applicable	_____	_____
DAY 4 DAY _____ DATE _____	____ PM/AM	____ PM/AM	____ Minutes	____ Times	<input type="checkbox"/> Refreshed <input type="checkbox"/> Somewhat refreshed <input type="checkbox"/> Fatigued	____ Hours	_____ _____ _____ _____	<input type="checkbox"/> Morning <input type="checkbox"/> Afternoon <input type="checkbox"/> Within several hours before going to bed <input type="checkbox"/> Not applicable	<input type="checkbox"/> Morning <input type="checkbox"/> Afternoon <input type="checkbox"/> Within several hours before going to bed <input type="checkbox"/> Not applicable	<input type="checkbox"/> Alcohol <input type="checkbox"/> A heavy meal <input type="checkbox"/> Not applicable	_____	_____

Revised Children's Anxiety and Depression Scale
(Child measure administered at first visit)

Date: _____

Name/ID: _____

RCADS

Please put a circle around the word that shows how often each of these things happen to you. There are no right or wrong answers.

- | | | | | |
|---|-------|-----------|-------|--------|
| 1. I worry about things | Never | Sometimes | Often | Always |
| 2. I feel sad or empty | Never | Sometimes | Often | Always |
| 3. When I have a problem, I get a funny feeling in my stomach | Never | Sometimes | Often | Always |
| 4. I worry when I think I have done poorly at something | Never | Sometimes | Often | Always |
| 5. I would feel afraid of being on my own at home | Never | Sometimes | Often | Always |
| 6. Nothing is much fun anymore | Never | Sometimes | Often | Always |
| 7. I feel scared when I have to take a test | Never | Sometimes | Often | Always |
| 8. I feel worried when I think someone is angry with me | Never | Sometimes | Often | Always |
| 9. I worry about being away from my parents | Never | Sometimes | Often | Always |
| 10. I get bothered by bad or silly thoughts or pictures in my mind | Never | Sometimes | Often | Always |
| 11. I have trouble sleeping | Never | Sometimes | Often | Always |
| 12. I worry that I will do badly at my school work . | Never | Sometimes | Often | Always |
| 13. I worry that something awful will happen to someone in my family | Never | Sometimes | Often | Always |
| 14. I suddenly feel as if I can't breathe when there is no reason for this | Never | Sometimes | Often | Always |
| 15. I have problems with my appetite | Never | Sometimes | Often | Always |
| 16. I have to keep checking that I have done things right (like the switch is off, or the door is locked) | Never | Sometimes | Often | Always |
| 17. I feel scared if I have to sleep on my own. | Never | Sometimes | Often | Always |

18. I have trouble going to school in the mornings because I feel nervous or afraid	Never	Sometimes	Often	Always
19. I have no energy for things	Never	Sometimes	Often	Always
20. I worry I might look foolish	Never	Sometimes	Often	Always
21. I am tired a lot	Never	Sometimes	Often	Always
22. I worry that bad things will happen to me	Never	Sometimes	Often	Always
23. I can't seem to get bad or silly thoughts out of my head.	Never	Sometimes	Often	Always
24. When I have a problem, my heart beats really fast	Never	Sometimes	Often	Always
25. I cannot think clearly	Never	Sometimes	Often	Always
26. I suddenly start to tremble or shake when there is no reason for this	Never	Sometimes	Often	Always
27. I worry that something bad will happen to me ..	Never	Sometimes	Often	Always
28. When I have a problem, I feel shaky	Never	Sometimes	Often	Always
29. I feel worthless	Never	Sometimes	Often	Always
30. I worry about making mistakes	Never	Sometimes	Often	Always
31. I have to think of special thoughts (like numbers or words) to stop bad things from happening. ...	Never	Sometimes	Often	Always
32. I worry what other people think of me	Never	Sometimes	Often	Always
33. I am afraid of being in crowded places (like shopping centers, the movies, buses, busy playgrounds)	Never	Sometimes	Often	Always
34. All of a sudden I feel really scared for no reason at all	Never	Sometimes	Often	Always
35. I worry about what is going to happen	Never	Sometimes	Often	Always
36. I suddenly become dizzy or faint when there is no reason for this	Never	Sometimes	Often	Always
37. I think about death	Never	Sometimes	Often	Always
38. I feel afraid if I have to talk in front of my class	Never	Sometimes	Often	Always
39. My heart suddenly starts to beat too quickly for no reason	Never	Sometimes	Often	Always
40. I feel like I don't want to move	Never	Sometimes	Often	Always
41. I worry that I will suddenly get a scared feeling when there is nothing to be afraid of	Never	Sometimes	Often	Always
42. I have to do some things over and over again (like washing my hands, cleaning or putting things in a certain order)	Never	Sometimes	Often	Always
43. I feel afraid that I will make a fool of myself in front of people	Never	Sometimes	Often	Always
44. I have to do some things in just the right way to stop bad things from happening	Never	Sometimes	Often	Always
45. I worry when I go to bed at night	Never	Sometimes	Often	Always
46. I would feel scared if I had to stay away from home overnight	Never	Sometimes	Often	Always
47. I feel restless	Never	Sometimes	Often	Always

Sleep Self Report
(Child measure administered at first visit)

Sleep Self Report
(Child's Form)

Coding

These questions are about your sleep. The researcher will explain the form and read you the questions in class. Please mark your answer to each question in the box. There are no right or wrong answers. Please ask if you do not understand a question. Thank you!

1. Who in your family sets the rules about when you go to bed?
☐ Mom ☐ Dad ☐ You ☐ Other: _____
2. Do you think you have trouble sleeping? ☐ Yes ☐ No
3. Do you like to go to sleep? ☐ Yes ☐ No

	Usually (5-7)/week	Sometimes (2-4)/week	Rarely (0-1)/week or never
<u>Bedtime</u>			
4. Do you go to bed at the same time every night on school nights?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Do you fall asleep in the same bed every night?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Do you fall asleep alone?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Do you fall asleep in your parents', brothers', or sister's bed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Do you fall asleep in about 20 minutes?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Do you fight with your parents about going to bed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Is it hard for you to go to bed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Are you ready for bed at your usual bedtime?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Do you have a special thing (doll, blanket, etc.) you bring to bed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Are you afraid of the dark?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. Are you afraid of sleeping alone?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. Do you stay up late when your parents think you are asleep?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<u>Sleep Behavior</u>			
16. Do you think you sleep too little?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. Do you think you sleep too much?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. Do you wake up at night when your parents think you're asleep?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19. Do you have trouble falling back to sleep if you wake up during the night?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20. Do you have nightmares?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21. Does pain wake you up at night? Where is that pain?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<hr/>			
22. Do you sometimes go to someone's bed during the night? If yes, who?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<hr/>			
<u>Daytime Sleepiness</u>			
23. Do you have trouble waking up in the morning?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24. Do you feel sleepy during the day?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25. Do you take naps during the day?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26. Do you feel rested after a night's sleep?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Youth Self Report (YSR)
(Child measure administered at first visit)

Please print. Be sure to answer all items.

Below is a list of items that describe kids. For each item that describes you **now or within the past 6 months**, please circle the 2 if the item is **very true or often true** of you. Circle the 1 if the item is **somewhat or sometimes true** of you. If the item is **not true** of you, circle the 0.

0 = Not True	1 = Somewhat or Sometimes True	2 = Very True or Often True	
0 1 2	1. I act too young for my age	0 1 2	33. I feel that no one loves me
0 1 2	2. I drink alcohol without my parents' approval (describe): _____	0 1 2	34. I feel that others are out to get me
0 1 2	3. I argue a lot	0 1 2	35. I feel worthless or inferior
0 1 2	4. I fail to finish things that I start	0 1 2	36. I accidentally get hurt a lot
0 1 2	5. There is very little that I enjoy	0 1 2	37. I get in many fights
0 1 2	6. I like animals	0 1 2	38. I get teased a lot
0 1 2	7. I brag	0 1 2	39. I hang around with kids who get in trouble
0 1 2	8. I have trouble concentrating or paying attention	0 1 2	40. I hear sounds or voices that other people think aren't there (describe): _____
0 1 2	9. I can't get my mind off certain thoughts; (describe): _____	0 1 2	41. I act without stopping to think
0 1 2	10. I have trouble sitting still	0 1 2	42. I would rather be alone than with others
0 1 2	11. I'm too dependent on adults	0 1 2	43. I lie or cheat
0 1 2	12. I feel lonely	0 1 2	44. I bite my fingernails
0 1 2	13. I feel confused or in a fog	0 1 2	45. I am nervous or tense
0 1 2	14. I cry a lot	0 1 2	46. Parts of my body twitch or make nervous movements (describe): _____
0 1 2	15. I am pretty honest	0 1 2	47. I have nightmares
0 1 2	16. I am mean to others	0 1 2	48. I am not liked by other kids
0 1 2	17. I daydream a lot	0 1 2	49. I can do certain things better than most kids
0 1 2	18. I deliberately try to hurt or kill myself	0 1 2	50. I am too fearful or anxious
0 1 2	19. I try to get a lot of attention	0 1 2	51. I feel dizzy or lightheaded
0 1 2	20. I destroy my own things	0 1 2	52. I feel too guilty
0 1 2	21. I destroy things belonging to others	0 1 2	53. I eat too much
0 1 2	22. I disobey my parents	0 1 2	54. I feel overtired without good reason
0 1 2	23. I disobey at school	0 1 2	55. I am overweight
0 1 2	24. I don't eat as well as I should	0 1 2	56. Physical problems without known medical cause:
0 1 2	25. I don't get along with other kids	0 1 2	a. Aches or pains (not stomach or headaches)
0 1 2	26. I don't feel guilty after doing something I shouldn't	0 1 2	b. Headaches
0 1 2	27. I am jealous of others	0 1 2	c. Nausea, feel sick
0 1 2	28. I break rules at home, school, or elsewhere	0 1 2	d. Problems with eyes (not if corrected by glasses) (describe): _____
0 1 2	29. I am afraid of certain animals, situations, or places, other than school (describe): _____	0 1 2	e. Rashes or other skin problems
0 1 2	30. I am afraid of going to school	0 1 2	f. Stomachaches
0 1 2	31. I am afraid I might think or do something bad	0 1 2	g. Vomiting, throwing up
0 1 2	32. I feel that I have to be perfect	0 1 2	h. Other (describe): _____

PAGE 3 **Be sure you answered all items. Then see other side.**

Please print. Be sure to answer all items.

0 = Not True			1 = Somewhat or Sometimes True			2 = Very True or Often True		
0	1	2	57. I physically attack people	0	1	2	84. I do things other people think are strange (describe): _____	
0	1	2	58. I pick my skin or other parts of my body (describe): _____	0	1	2	85. I have thoughts that other people would think are strange (describe): _____	
0	1	2	59. I can be pretty friendly	0	1	2	86. I am stubborn	
0	1	2	60. I like to try new things	0	1	2	87. My moods or feelings change suddenly	
0	1	2	61. My school work is poor	0	1	2	88. I enjoy being with people	
0	1	2	62. I am poorly coordinated or clumsy	0	1	2	89. I am suspicious	
0	1	2	63. I would rather be with older kids than kids my own age	0	1	2	90. I swear or use dirty language	
0	1	2	64. I would rather be with younger kids than kids my own age	0	1	2	91. I think about killing myself	
0	1	2	65. I refuse to talk	0	1	2	92. I like to make others laugh	
0	1	2	66. I repeat certain acts over and over (describe): _____	0	1	2	93. I talk too much	
0	1	2	67. I run away from home	0	1	2	94. I tease others a lot	
0	1	2	68. I scream a lot	0	1	2	95. I have a hot temper	
0	1	2	69. I am secretive or keep things to myself	0	1	2	96. I think about sex too much	
0	1	2	70. I see things that other people think aren't there (describe): _____	0	1	2	97. I threaten to hurt people	
0	1	2	71. I am self-conscious or easily embarrassed	0	1	2	98. I like to help others	
0	1	2	72. I set fires	0	1	2	99. I smoke, chew, or sniff tobacco	
0	1	2	73. I can work well with my hands	0	1	2	100. I have trouble sleeping (describe): _____	
0	1	2	74. I show off or clown	0	1	2	101. I cut classes or skip school	
0	1	2	75. I am too shy or timid	0	1	2	102. I don't have much energy	
0	1	2	76. I sleep less than most kids	0	1	2	103. I am unhappy, sad, or depressed	
0	1	2	77. I sleep more than most kids during day and/or night (describe): _____	0	1	2	104. I am louder than other kids	
0	1	2	78. I am inattentive or easily distracted	0	1	2	105. I use drugs for nonmedical purposes (<i>don't</i> include alcohol or tobacco) (describe): _____	
0	1	2	79. I have a speech problem (describe): _____	0	1	2	106. I like to be fair to others	
0	1	2	80. I stand up for my rights	0	1	2	107. I enjoy a good joke	
0	1	2	81. I steal at home	0	1	2	108. I like to take life easy	
0	1	2	82. I steal from places other than home	0	1	2	109. I try to help other people when I can	
0	1	2	83. I store up too many things I don't need (describe): _____	0	1	2	110. I wish I were of the opposite sex	
				0	1	2	111. I keep from getting involved with others	
				0	1	2	112. I worry a lot	

Please be sure you answered all items.

Please write down anything else that describes your feelings, behavior, or interests:

Positive and Negative Affect Schedule for Children
(Child measure administered at first visit)

ID# _____

Feelings and Emotions (PANAS-C)

This scale consists of a number of words that describe different feelings and emotions.

Read each item and then circle the appropriate answer next to that word.

Indicate how much you have felt this way during the past few weeks right now (experimenter will indicate which time period).

	Not much or not at all	A little	Some	Quite a bit	A lot
Interested	1	2	3	4	5
Sad	1	2	3	4	5
Frightened	1	2	3	4	5
Alert	1	2	3	4	5
Excited	1	2	3	4	5
Ashamed	1	2	3	4	5
Upset	1	2	3	4	5
Happy	1	2	3	4	5
Strong	1	2	3	4	5
Nervous	1	2	3	4	5
Guilt	1	2	3	4	5
Energetic	1	2	3	4	5
Scared	1	2	3	4	5
Calm	1	2	3	4	5
Miserable	1	2	3	4	5
Jittery	1	2	3	4	5
Cheerful	1	2	3	4	5
Active	1	2	3	4	5
Proud	1	2	3	4	5
Afraid	1	2	3	4	5
Joyful	1	2	3	4	5
Lonely	1	2	3	4	5
Mad	1	2	3	4	5
Fearless	1	2	3	4	5
Disgusted	1	2	3	4	5
Delighted	1	2	3	4	5
Blue	1	2	3	4	5
Daring	1	2	3	4	5
Gloomy	1	2	3	4	5
Lively	1	2	3	4	5

Positive and Negative Affect Schedule for Children
 (Child measure administered at second visit)

ID# _____

Feelings and Emotions (PANAS-C)

This scale consists of a number of words that describe different feelings and emotions.

Read each item and then circle the appropriate answer next to that word.

Indicate how much you have felt this way during the past few weeks right now (experimenter will indicate which time period).

	Not much or not at all	A little	Some	Quite a bit	A lot
Interested	1	2	3	4	5
Sad	1	2	3	4	5
Frightened	1	2	3	4	5
Alert	1	2	3	4	5
Excited	1	2	3	4	5
Ashamed	1	2	3	4	5
Upset	1	2	3	4	5
Happy	1	2	3	4	5
Strong	1	2	3	4	5
Nervous	1	2	3	4	5
Guilty	1	2	3	4	5
Energetic	1	2	3	4	5
Scared	1	2	3	4	5
Calm	1	2	3	4	5
Miserable	1	2	3	4	5
Jittery	1	2	3	4	5
Cheerful	1	2	3	4	5
Active	1	2	3	4	5
Proud	1	2	3	4	5
Afraid	1	2	3	4	5
Joyful	1	2	3	4	5
Lonely	1	2	3	4	5
Mad	1	2	3	4	5
Fearless	1	2	3	4	5
Disgusted	1	2	3	4	5
Delighted	1	2	3	4	5
Blue	1	2	3	4	5
Daring	1	2	3	4	5
Gloomy	1	2	3	4	5
Lively	1	2	3	4	5

Positive and Negative Affect Schedule for Children
(Child measure administered at second visit)

HOW-I-FEEL QUESTIONNAIRE

Developed by C.D. Spielberger, C.D. Edwards, J. Montouri, and R. Lushene

STAIC Form C-1

Name: _____ Age: _____ Date: _____

DIRECTIONS: A number of statements which boys and girls use to describe themselves are given below. Read each statement carefully and decide how you feel *right now*. Then put an X in the box in front of the word or phrase which best describes how you feel. There are no right or wrong answers. Don't spend too much time on any one statement. Remember, find the word or phrase which best describes how you feel right now, *at this very moment*.

- | | | | |
|------------------|--|-------------------------------------|---|
| 1. I feel | <input type="checkbox"/> very calm | <input type="checkbox"/> calm | <input type="checkbox"/> not calm |
| 2. I feel | <input type="checkbox"/> very upset | <input type="checkbox"/> upset | <input type="checkbox"/> not upset |
| 3. I feel | <input type="checkbox"/> very pleasant | <input type="checkbox"/> pleasant | <input type="checkbox"/> not pleasant |
| 4. I feel | <input type="checkbox"/> very nervous | <input type="checkbox"/> nervous | <input type="checkbox"/> not nervous |
| 5. I feel | <input type="checkbox"/> very jittery | <input type="checkbox"/> jittery | <input type="checkbox"/> not jittery |
| 6. I feel | <input type="checkbox"/> very rested | <input type="checkbox"/> rested | <input type="checkbox"/> not rested |
| 7. I feel | <input type="checkbox"/> very scared | <input type="checkbox"/> scared | <input type="checkbox"/> not scared |
| 8. I feel | <input type="checkbox"/> very relaxed | <input type="checkbox"/> relaxed | <input type="checkbox"/> not relaxed |
| 9. I feel | <input type="checkbox"/> very worried | <input type="checkbox"/> worried | <input type="checkbox"/> not worried |
| 10. I feel | <input type="checkbox"/> very satisfied | <input type="checkbox"/> satisfied | <input type="checkbox"/> not satisfied |
| 11. I feel | <input type="checkbox"/> very frightened | <input type="checkbox"/> frightened | <input type="checkbox"/> not frightened |
| 12. I feel | <input type="checkbox"/> very happy | <input type="checkbox"/> happy | <input type="checkbox"/> not happy |
| 13. I feel | <input type="checkbox"/> very sure | <input type="checkbox"/> sure | <input type="checkbox"/> not sure |
| 14. I feel | <input type="checkbox"/> very good | <input type="checkbox"/> good | <input type="checkbox"/> not good |
| 15. I feel | <input type="checkbox"/> very troubled | <input type="checkbox"/> troubled | <input type="checkbox"/> not troubled |
| 16. I feel | <input type="checkbox"/> very bothered | <input type="checkbox"/> bothered | <input type="checkbox"/> not bothered |
| 17. I feel | <input type="checkbox"/> very nice | <input type="checkbox"/> nice | <input type="checkbox"/> not nice |
| 18. I feel | <input type="checkbox"/> very terrified | <input type="checkbox"/> terrified | <input type="checkbox"/> not terrified |
| 19. I feel | <input type="checkbox"/> very mixed-up | <input type="checkbox"/> mixed-up | <input type="checkbox"/> not mixed-up |
| 20. I feel | <input type="checkbox"/> very cheerful | <input type="checkbox"/> cheerful | <input type="checkbox"/> not cheerful |

State-Trait Anxiety Inventory for Children
(Child measure administered at first and second visit)

HOW-I-FEEL QUESTIONNAIRE

STAIC Form C-2

Name: _____ Age: _____ Date: _____

DIRECTIONS: A number of statements which boys and girls use to describe themselves are given below. Read each statement carefully and decide if it is *hardly-ever*, or *sometimes*, or *often* true for you. Then for each statement, put an X in the box in front of the word that seems to describe you best. There are no right or wrong answers. Don't spend too much time on any one statement. Remember, choose the word which seems to describe how you usually feel.

- | | | | |
|---|--------------------------------------|------------------------------------|--------------------------------|
| 1. I worry about making mistakes..... | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 2. I feel like crying | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 3. I feel unhappy..... | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 4. I have trouble making up my mind | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 5. It is difficult for me to face my problems | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 6. I worry too much..... | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 7. I get upset at home | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 8. I am shy..... | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 9. I feel troubled | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 10. Unimportant thoughts run through my mind
and bother me | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 11. I worry about school | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 12. I have trouble deciding what to do..... | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 13. I notice my heart beats fast | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 14. I am secretly afraid | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 15. I worry about my parents | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 16. My hands get sweaty..... | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 17. I worry about things that may happen | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 18. It is hard for me to fall asleep at night..... | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 19. I get a funny feeling in my stomach | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |
| 20. I worry about what others think of me..... | <input type="checkbox"/> hardly-ever | <input type="checkbox"/> sometimes | <input type="checkbox"/> often |

Epworth Sleepiness Scale
(Child measure administered at first and second visit)

ID# _____

ESS

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired, right now? Use the following scale to choose the most appropriate number for each situation:

0 = would **never** doze

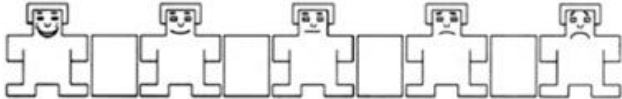
1 = **slight chance** of dozing

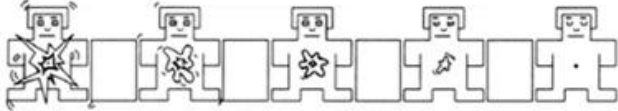
2 = **moderate chance** of dozing

3 = **high chance** of dozing


SITUATION	CHANCE OF DOZING (0-3)
Sitting and reading	
Watching television	
Sitting inactive in a public place (e.g. a theater or a meeting)	
As a passenger in a car for an hour without a break	
Lying down to rest in the afternoon when circumstances permit	
Sitting and talking to someone	
Sitting quietly after a lunch without alcohol	
In a car, while stopped for a few minutes in the traffic	
TOTAL SCORE	

IAPS Rating Scale: Self-Assessment Manikin (SAM)
(Administered with Adolescent Cognitive Reappraisal Task)

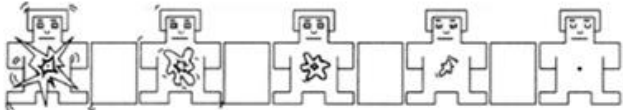
1. Positive  Negative

Excited  Calm


2. Positive  Negative

Excited  Calm

3. Positive  Negative

Excited  Calm

4. Positive  Negative

Excited  Calm