

Poor sleep quality is associated with decreased emotional arousal in healthy girls

Candice A. Alfano, Ph.D., Radhika Reddy, M.A., Katharine C. Reynolds, B.A.,

Heather Pane, M.A., Tyson Reuter, B.A. & Carla Sharp, Ph.D.

*Department of Psychology, University of Houston*

*Keywords:* Sleep; Emotional Processing; Children; Adolescents; International Affective Picture System; Females

Corresponding Author: Candice Alfano, Ph.D., Department of Psychology, University of Houston, 126 Heyne Building, Houston, TX 77204. Email: [caalfano@uh.edu](mailto:caalfano@uh.edu); Phone: 1.713.743.8600. Fax: 1.713.743.8633.

### Abstract

A growing number of studies in adults document critical relationships between sleep and emotional processing based on responses to affective images from the International Affective Picture System (IAPS; Lang, Bradley & Cuthbert, 2005). Our aim was to extend examination of the interrelationships between sleep and emotional processing to a sample of healthy girls, ages 10 to 16 years. A total of 86 girls ( $M=12.88$  years,  $SD=1.92$ ) without psychiatric disorders were recruited. In addition to structured diagnostic interviews, report of sleep quality was examined in relation to valence and arousal ratings of pleasant, neutral and unpleasant IAPS images. Overall, picture ratings were consistent with findings from previous research showing pleasant images to produce high arousal and valence ratings in childhood and that these relationships decrease with age. Regression models revealed poor sleep quality to be associated with decreased subjective arousal in response to negative/unpleasant images, but not pleasant or neutral images. Findings are discussed in terms of a need for more research aimed at better elucidating how sleep quality during the childhood years relates to the processing of emotional information.

## Introduction

Across the developmental spectrum, poor sleep quality is a feature of and risk factor for affective disorders (Alfano & Gamble, 2009; Ford & Kamerow, 1989). Prospective studies confirm the predictive utility of sleep problems for anxiety and mood disorders over periods of 10, 20 and even 40 years (Chang, Ford, Mead, Cooper-Patrick & Klag, 1997; Gregory, Eley, O'Connor & Plomin, 2004; Gregory et al., 2005; Mallon, Broman & Hetta 2000). Although precise mechanisms through which these problems are linked remain unknown, emerging data suggest that inadequate sleep may undermine adaptive emotional processing vis-à-vis integrated systems of arousal and regulation. For example, sleep deprivation protocols in healthy individuals has been shown to produce progressive decrements in self-reported mood, motivation and energy, diminished vocal expression of positive emotion, and decreased optimism and sociability (Haack & Mullington, 2005; McGlinchey et al., 2011; Pilcher & Huffcutt, 1996; Talbot et al., 2010).

A number of recent experimental studies have examined the impact of sleep deprivation on subjective emotional processing using the International Affective Picture System (IAPS; Lang, Bradley & Cuthbert, 2005), a set of visual affective stimuli in response to which individuals rate emotional valence and arousal (i.e., two separate but related dimensions of emotion). Overall results have varied considerably. In an adult all-female sample, participants assigned to a sleep deprivation condition rated neutral IAPS images as more negatively-valenced than a rested group (Tempesta et al., 2010). In another study, valence ratings of all IAPS images were more positive following sleep deprivation (Gunar, Yoo, Hu & Walker, 2011). Among an all-male sample, unpleasant IAPS images were rated as less negatively-valenced following periods of wakefulness as compared to sleep (Wagner, Fischer & Born, 2002). Whereas findings for valence ratings have diverged considerably, most studies have not found differences in self-reported arousal ratings based on sleep manipulation in adults.

Differences across studies are suggestive of a number of potential moderating influences on emotion-based outcomes. First, although lab-based manipulation of sleep represents an important investigative approach, the extent to which prolonged periods of wakefulness in a laboratory produce changes in emotional responses analogous to more typical (i.e., naturalistic) patterns of poor sleep is unknown. Sex-based differences also appear salient. On average females experience higher rates of insomnia and report greater levels of daytime sleepiness than males (Akerstedt, Fredlund, Gillberg & Jansson, 2002; Zhang & Wing, 2006). Additionally, while sleep disruption represents an important marker of depression and anxiety risk (Gregory et al., 2005; Johnson, Chilcoat & Bresalu, 2000) a more robust association appears to exist in females (Mallon, Broman & Hetta, 2000). Such findings have guided suggestion that females possess a greater vulnerability to the effects of sleep loss than males, particularly in the context of emotional processing (Van der Helm, Gunar & Walker, 2010).

The role of development represents one of the largest gaps in available research. Early sleep patterns and emotional processing are intertwined by the same bioregulatory systems and the bidirectional effects of these domains are well-recognized (Dahl, 1996). Concurrent with normative changes in sleep need, emotional processing undergoes certain predictable developmental changes from childhood to adulthood. For example, research using the IAPS reveals pleasant/positive images to produce the highest levels of arousal in children whereas unpleasant/negative images elicit high levels of arousal in adults (McManis, Bradley, Berg, Cuthbert, & Lang, 2001; Sharp, van Goozen & Goodyer, 2006). That is, despite an overall quadratic relationship between valence and arousal ratings across all age groups (McManis et al., 2001; Sharp, et al., 2006), arousal in relation to unpleasant images increases with age while the opposite pattern emerges for pleasant images. The extent to which (typical) sleep quality influences emotional processing in response to IAPS images has not been examined in youth, yet previous research indicating poor sleep quality predicts deficits in emotional processing

during the pre to early adolescent years nonetheless suggests this to be a worthy area of inquiry (Soffer-Dudek et al., 2011).

Based on established high rates of affective disorders in females (Kessler & Walters, 1998; Lewinsohn, Rohde & Seeley, 1998), the current study aimed to examine relationships between typical sleep quality and emotional processing in a sample of healthy girls without psychiatric diagnoses, ages 10 to 16 years. More specifically, subjective ratings in response to affective IAPS images were examined in relation to sleep quality during a retrospective two-week period. Previous studies examining IAPS responses in relation to sleep during childhood are unavailable so hypotheses were derived from developmental research showing pleasant images to elicit the highest levels of arousal in children. Specifically, we hypothesized that poor sleep quality would be associated with atypical developmental responses to IAPS images including decreased ratings of arousal and valence for pleasant images in our sample of healthy girls.

## Methods

### Participants

The current investigation used archival data from a study funded by the National Alliance for Research on Schizophrenia and Depression (NARSAD) examining the intergenerational transmission of depression from mothers to daughters (awarded to the last author). Families were recruited from several sources within the Houston, Texas area. In particular, three groups were recruited: 1) depressed biological daughters of depressed mothers; 2) non-depressed biological daughters of depressed mothers; and 3) healthy daughters of healthy mothers. For the current study, healthy girls (i.e., without any Axis I psychopathology) of both depressed and non-depressed mothers were included. The final sample included 86 girls, 10 to 16 years ( $M=12.88$ ,  $SD=1.92$ ). The majority of participants identified their race as Caucasian (43%), followed by Black/African-American (25.6%), multiracial (14%) or as American Indian/Alaskan American (3.5%). Approximately one half (54.7%) were of Hispanic ethnicity. Annual household

income ranged from <\$10,000 to  $\geq$ \$200,000 per year with the mean annual income falling between \$40K to \$49K and the greatest proportion of individuals earning between \$20 and \$29K (12.8%). Highest level of maternal education ranged from some high school (12.8%) to a graduate level degree (10.5%). The majority of participants had parents who were married (54.7%), followed by parents who were divorced (15.1%), single or never married (12.8%), separated (11.6%), living together (4.7%), or widowed (1.2%).

All participants (and their mother) underwent comprehensive assessment procedures including structured interviews and completion of a battery of questionnaires. Besides the presence of any Axis I psychiatric diagnosis, exclusion criteria included mental retardation and/or active medical or neurologic disorder.

Of the 86 participants, 47 (54.7%) had a mother with a current or lifetime diagnosis of depression based on structured interviews with the Clinical Interview for DSM-IV Axis I Disorders, Non-patient Edition (SCID-I/NP; First et al., 2002). We therefore examined whether girls with (n=47) and without (n=39) a depressed mother differed on any demographic or clinical measures, including sleep quality. No significant differences were found between the groups on any variable or measure.

#### Clinical Measures

*Computerized Diagnostic Interview Schedule for Children-IV (CDISC-IV; Shaffer, et al., 2000).* The CDISC was used to assess the presence of current and lifetime psychiatric disorders in children. This computerized diagnostic instrument consists of 283 items designed to measure criteria for DSM-IV child and adolescent diagnoses. The following twenty sections of the CDISC-IV were administered: Specific Phobia, Separation Anxiety Disorder, Phobia, Panic Disorder, Agoraphobia, Generalized Anxiety Disorder, Obsessive Compulsive Disorder, Post-traumatic Stress Disorder, Disorders, Major Depression Disorder, Dysthymia, Mania/Hypomania, Schizophrenia, Attention-Deficit/Hyperactivity, Defiant Disorder, Conduct Disorder, Alcohol Use Disorder, Nicotine Dependence, Marijuana Use Disorders, and Other

Substance Use Disorders. Inter-rater reliability for the CDISC has been demonstrated with clinician-CDISC diagnosis agreement of 97% (Wolfe, Toro & McCaskill, 1999).

*The Mood and Feelings Questionnaire (MFQ long form; Angold, Costello, Messer, & Pickles, 1995).* The MFQ is a 33-item measure for youth ages 6 to 17 years used to screen for clinically significant symptoms of depressive disorders experienced during the past two weeks. Youth are asked to report on symptoms derived from the DSM-IV depressive disorder criteria that include loneliness, somatic complaints, tearfulness, and worries about the future experiences using a 3-point likert-type rating scale (i.e. true, sometimes true, not true). Excellent internal consistency has been demonstrated ( $\alpha = 0.92$ ; Wood, Kroll, Moore, & Harrington, 1995). Internal consistency in the current sample was excellent (Cronbach's alpha = .89).

*Sleep Quality.* Sleep quality was assessed based on items from other youth-report measures (e.g., Alfano et al., 2009). Based on item content, three sleep-related items from the MFQ ("I felt so tired I just sat around and did nothing", "I didn't sleep as well as I usually sleep" and "I slept a lot more than usual") were identified. A principal components analysis of these items was then conducted to identify items accounting for the greatest variance in Sleep Quality scores. Results produced a single factor consisting of two items from the MFQ (#5 - I felt so tired I just sat around and did nothing, and #32 - I didn't sleep as well as I usually sleep), which accounted for 55% of the variance in Sleep Quality scores. Responses on these two items were therefore standardized and converted to z-scores for analysis. Internal consistency for the scale was low (Spearman-Brown Coefficient=.57) but consistent with previous research utilizing similar sleep scales (e.g., Gregory et al, 2005; Gregory et al, 2004).

Emotional Processing Assessment

*International Affective Pictures System (IAPS; Lang, Bradley, & Cuthbert, 2005).* IAPS includes a series of color images developed by Lang and colleagues (2005) which include a range of pleasant, unpleasant, and neutral pictures (based on affective content) typically used to

measure two dimensions of emotion processing, valence and arousal/intensity. Both standardized dimensions are assessed based on a 9 point scale where 1 = low arousal or negative valence and 9 = high arousal or positive valence. Previously, several studies have used the IAPS successfully with children (McManis et al., 2001; Sharp et al., 2008; Sharp et al., 2006). For studies using the IAPS with the Self-Assessment Manikin rating system (SAM; Lang, 1980), excellent internal consistency has been documented for valence and arousal ratings (Bucks, da Silva, & Han, 2005; Lang et al., 2005).

For the current study, a subset of 15 IAPS images was selected representing the full range of valence and arousal dimensions (i.e., unpleasant, pleasant and neutral images). Following previous studies, summary scores for each picture type were determined for valence and arousal separately to create six summary variables of emotional processing. Internal consistency for these variables was moderate to excellent: valence for unpleasant pictures ( $\alpha=.75$ ); valence for neutral pictures ( $\alpha=.54$ ); valence for pleasant pictures ( $\alpha=.59$ ); arousal to unpleasant pictures ( $\alpha=.90$ ); arousal to neutral pictures ( $\alpha=.78$ ); and arousal to pleasant pictures ( $\alpha=.88$ ). Lower alphas for two of the six categories are interpreted in the context of only a small number of pictures used in each category. These estimates also are consistent with previous findings indicating lower internal consistency estimates for valence as compared to arousal ratings (Bucks et al., 2005).

#### Procedures

The study was approved by the appropriate institutional review board. Mother-daughter dyads presented to an outpatient clinic where all study procedures were explained and written consent/assent to participate was required. Families were financially compensated for their time. Separate diagnostic interviews were conducted by a doctoral level clinical psychology student or a trained undergraduate research assistant. All measures and assessment based on the IAPS were completed on the same day, typically between the hours of 16:00 to 19:00.



Each participant viewed IAPS images in the same random, fixed sequence on a 15" computer monitor in a quiet, private room. The content (and order) of images included: man, dying man, fork, soldier, ice cream, roller coaster, cemetery, rock climber, lightning, dolphins, burn victim, gun attack, bear, boy scream, sports car, and puppies. Each image was viewed as a PowerPoint slide for 9 seconds followed by a blank (untimed) slide during which participants completed ratings of valence and arousal using the 9-point SAM rating scales. The valence scale consisted of a cartoon-like figure in which nine human emotional expressions, ranging from smiling and happy to frowning and unhappy, are represented. Likewise, the arousal scale included another cartoon-like figure with nine expressions ranging from calm and relaxed to wide-eyed and excited.

## Results

### *Validity of IAPS Responses*

Valence categories to which each image was assigned (a priori) based on published norms matched participant ratings for in the current study. Specific values as well as normative values provided by Lang et al. (2005) are provided in Table 1 for comparison purposes. Overall, valence and arousal ratings in our sample were consistent with ratings from previous research in children (Lang et al., 1999; McManis et al., 2001).

### *IAPS Responses x Age*

We examined whether age was related to valence and arousal ratings across the image categories using Pearson's correlation coefficients. Age was significantly negatively associated with valence of pleasant IAPS pictures ( $r = -.37, p < .001$ ). Negative correlations between age and arousal ratings for pleasant ( $r = -.21, p = .058$ ) and neutral ( $r = -.21, p = .056$ ) pictures just failed to reach significance.

### *IAPS Responses x Affective Category*

A repeated measures ANOVA was used to compare valence ratings across the image categories (pleasant, neutral, negative). A significant main effect for valence [ $F(2, 84) = 718.41$ ,

$p < .001$ ,  $\eta^2 = .945$ ] emerged. Consistent with previous research (Sharp et al., 2006), follow-up least significant difference (LSD) tests indicated significant differences between all three valence categories including significantly higher valence ratings for positive/pleasant pictures, followed by neutral and then unpleasant/negative pictures. Arousal ratings across the image categories also were compared using a repeated measures ANOVA. A significant main effect emerged for arousal ratings [ $F(2, 84) = 90.47$ ,  $p < .001$ ,  $\eta^2 = .683$ ] with follow-up tests indicating significantly higher arousal ratings for pleasant and unpleasant pictures than for neutral pictures ( $p < .001$ ).

#### *Sleep Quality as a Predictor of IAPS Responses*

Six hierarchical linear regression models were examined with valence and arousal ratings as criterion variables. Maternal depression status and age were entered on the first step (to control for the possible influence of these variables) and sleep quality was entered on the second step. The model predicting arousal in response to unpleasant (negative) images revealed sleep quality as a significant predictor ( $\beta = -.26$ ,  $t(81) = -2.48$ ,  $p < .05$ ). Specifically, poorer sleep quality was a significant predictor of lower level of arousal in response to unpleasant images (see Table 2). None of the other regression models produced significant findings.

#### Discussion

Sleep is known to play a critical role in facilitating adaptive affective functioning, but these relationships remain relatively unexplored in youth. In the current study affective images from the IAPS were utilized to assess emotional processing in a sample of healthy girls. From a developmental standpoint, overall results are largely consistent with previous findings showing youth to provide the highest ratings of arousal in response to pleasant images (Bradley et al., 2001; McManis et al., 2001; Sharp et al., 2006). We also found a significant negative association between age and valence ratings of pleasant pictures, indicating a normative

decrease in arousal and valence ratings of positive images with age. These results add to a limited number of studies in children by replicating developmental differences in emotional processing between children and adults using picture interpretation methodology.

With regard to the study's primary aim, we found poorer sleep quality to be associated with decreased ratings of arousal in response to unpleasant/negative images. Predictable developmental changes in emotional processing are salient in interpreting this result. Specifically, an association between poorer sleep quality and decreased reactivity to unpleasant images stands in contrast to normative increases in arousal for negative images across early childhood and adolescence. Interestingly, Sharp et al. (2006) found a significant correlation between decreased arousal for unpleasant images and teacher-reported oppositional and antisocial behaviors in a community sample of boys and girls 7 to 11 years. Since healthy girls in the current study underwent comprehensive clinical assessment including structured interviews it seems unlikely that elevated rates of antisocial traits were present in our sample. Our findings nonetheless suggest that, even in psychologically healthy children, poor sleep quality may correspond with maladaptive changes in emotional processing.

Overall, findings align with a growing body of research indicating the quality of children's sleep to have implications for the processing of emotional information. Given the established rise in depression rates in girls during the age range examined (Lewinsohn et al., 1998), alterations in emotional processing during this particular period may have significant affective consequences. That reduced arousal was found in response to unpleasant but no other picture type also fits with previous suggestion that the effects of sleep are most pronounced for stimuli that require regulation of negative emotions (Yoo et al., 2007; Franzen et al., 2008).

This finding also stands in contrast to results from adult studies showing sleep deprivation to produce robust effects in terms of IAPS valence but not arousal ratings (although directionality of results differs across investigations). For example, in an all-female adult sample, sleep deprivation resulted in more negatively-valenced ratings of neutral images whereas

arousal ratings were not impacted. Of course, in addition to developmental differences it must be underscored that we did not use an experimental sleep manipulation in the current study, instead relying on child-reported sleep quality during the previous two weeks. A divergence of results may in part reflect these methodological differences.

A finding of decreased subjective arousal in relation to poor sleep quality may seem puzzling in light of previous experimental research providing evidence of increased physiologic reactivity following sleep deprivation in response to negative images (e.g., Franzen, Buysse, Dahl, Thompson & Siegle, 2008). In one study, Franzen et al. (2008) found that sleep-deprived subjects exhibited increased pupil dilation, a measure of sympathetic arousal, when viewing negative IAPS stimuli. Unfortunately, such research is currently limited to adult samples and available studies of objective emotional reactivity in children indicate differential patterns of arousal during early development. For example, McManis et al. (2001) found greater heart rate deceleration in children when viewing unpleasant compared to pleasant IAPS pictures, whereas heart rate did not vary as a function of picture content among adults. These data suggest that children may both interpret and attempt to regulate their emotional responses differently. It is also important to note that ratings provided in the current study were untimed following a 9-second viewing of each image. Ratings of arousal do not therefore necessarily reflect children's instantaneous responses to images but may instead have captured effortful attempts to regulate underlying reactivity. This remains a question for future research.

Several limitations are noteworthy in our study. First, it is possible that a third variable such as fatigue or distractibility might better account for our findings. As sleep quality predicted decreased arousal in response to unpleasant affective images only, this possibility nonetheless seems unlikely. Second, in the absence of an independent, validated measure of sleep, sleep quality was examined based on factor analysis of sleep-related items from another instrument. Although a number of previous studies have similarly relied on items from narrow-band measures of affective symptoms to assess sleep quality (e.g., Alfano et al., 2009; Gregory et al,

2005; Paavonen et al., 2000; Paavonen et al., 2002), these preliminary findings require replication using more rigorous sleep assessments. In addition, the extent to which our measure of sleep quality during the previous two weeks captured transient as compared to more persistent sleep problems is unknown. Since our study included females only findings cannot be generalized to males or mixed gender samples. Based on the use of a correlational design, assumptions regarding directionality cannot be made and it remains unclear whether poor sleep quality precedes alteration in emotional processing, whether aspects of emotional processing negatively impact sleep, or both. Lastly, as mentioned, sleep loss that accumulates over a period of time (e.g., two weeks) likely exerts differential influence on emotional responses than more prolonged periods of deprivation. Naturalistic sleep restriction protocols in child samples are needed to best address this issue.

In conclusion, findings add to a small but growing literature focused on the interrelationships between sleep and emotional processing in childhood. Our results suggest that, among healthy girls without psychiatric disorders, poor sleep quality is associated with emotional responses characterized by decreased arousal when viewing unpleasant/negative affective images. Future studies examining boys and girls across different developmental periods and incorporating more objective measures of sleep and arousal are needed to replicate and expand these findings.

### Acknowledgements

This research was supported by a NARSAD Young Investigator Award to Dr. Carla Sharp.

## References

- Alfano, C.A. & Gamble, A. (2009). The role of sleep in childhood psychiatric disorders. *Child Youth Care Forum, 38*, 327-340
- Alfano, C. A., Zakem, A. H., Costa, N. M., Taylor, L. K., & Weems, C. F. (2009). Sleep problems and their relation to cognitive factors, anxiety, and depressive symptoms in children and adolescents. *Depression and Anxiety, 26*(6), 503-512.
- Akerstedt, T., Fredlund, P., Gillberg, M., & Jansson, B. (2002). Work load and work hours in relation to disturbed sleep and fatigue in a large representative sample. *Journal of Psychosomatic Research, 53*, 585–588.
- Angold, A., Costello, E. J., Messer, S. C., & Pickles, A. (1995). Development of a short questionnaire for use in epidemiological studies of depression in children and adolescents. *International Journal of Methods in Psychiatric Research, 5*, 237–249.
- Backs, R. W., da Silva, S. P., & Han, K. (2005). A comparison of younger and older adults' Self-Assessment Manikin ratings of affective pictures. *Experimental Aging Research, 31*, 1-20.
- Bradley, M.M., Codispoti, M., Sabatinelli, D., & Lang, P.J. (2001). Emotion and motivation II: Sex differences in picture processing. *Emotion, 1*, 300-319.
- Carskadon, M. A. (2002). *Adolescent sleep patterns biological, social, and psychological influences*. Cambridge, U.K.: Cambridge University Press.
- Dahl, R.E. (1996). The regulation of sleep and arousal: development and psychopathology. *Development and Psychopathology, 8*, 3-27
- Daviss, W.B., Birmaher, B., Melhem, N.A., Axelson, D.A., Michaels, S.M., & Brent, D.A. (2006). Criterion validity of the Mood and Feelings Questionnaire for depressive episodes in clinic and non-clinic subjects. *Journal of Child Psychology and Psychiatry, 47*, 927-934.

- First, M.B., Spitzer, R.L., Gibbon, M. & Williams, J.B.W. (2002). *Structured Clinical Interview for DSM-IV-TR Axis I Disorders – Non-patient Edition (SCID-I/NP)*. New York: Biometrics Research, New York State Psychiatric Institute.
- Ford, D.E., & Kamerow, D.B. (1989). Epidemiologic study of sleep disturbances and psychiatric disorders. An opportunity for prevention? *Journal of the American Medical Association*, *262*, 1479-84.
- Franzen, P.L., Buysse, J.J., Dahl, R.E., Thompson, W., & Siegle, G.J. (2008). Sleep deprivation alters pupillary reactivity to emotional stimuli in healthy young adults. *Biological Psychology*, *80*, 300-305.
- Gregory, A.M., Caspi, A., Eley, T.C., Moffitt, T.E., O'Connor, T.G., & Poulton, R. (2005). Prospective longitudinal associations between persistent sleep problems in childhood and anxiety and depression disorders in adulthood. *Journal of Abnormal Child Psychology*, *33*, 157-163.
- Gregory, A.M., Eley, T.C., O'Connor, T.G., & Plomin, R. (2004). Etiologies of associations between childhood sleep and behavioral problems in a large twin sample. *Journal of the American Academy of Child & Adolescent Psychiatry*, *43*, 744-751
- Johnson, E.O., Chilcoat, H.D. & Bresalu, N. (2000). Trouble sleeping and anxiety/depression in childhood. *Psychiatry Research*, *94*, 93-102
- Kessler, R. C., & Walters, E. E. (1998). Epidemiology of *DSM-III-R* major depression and minor depression among adolescents and young adults in the national comorbidity survey. *Depression and Anxiety*, *7*, 3–14.
- Lang, P.J. (1980). Behavioral treatment and bio-behavioral assessment: computer applications. In J.B. Sidowski, J.H. Johnson, T.A. Williams (Eds.), *Technology in mental health care delivery systems* (pp. 119–137). Norwood, NJ; Ablex.
- Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (1998). Emotion, motivation, and anxiety: Brain mechanisms and psychophysiology. *Biological Psychiatry*, *44*, 1248-1263.



- Lang P.J., Bradley M.M., & Cuthbert, B.N. (1999). *International Affective Picture System (IAPS): Instruction manual and affective ratings. Technical Report A-4*. Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.
- Lang, P.J., Bradley, M.M. & Cuthbert, B.N. (2005). *International Affective Picture System (IAPS): Instruction manual and affective ratings. Technical Report A-6*. Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.
- Lewinsohn, P. M., Rohde, P., & Seeley, J. R. (1998). Major depressive disorder in older adolescents: Prevalence, risk factors, and clinical implications. *Clinical Psychology Review, 18*, 765–794.
- Malcolm, R., Myrick, L.H., Veatch, L.M., Boyle, E., & Randall, P.K. (2007). Self-reported sleep, sleepiness, and repeated alcohol withdrawals: A randomized, double blind, controlled comparison of lorazepam vs gabapentin. *Journal of Clinical Sleep Medicine, 3*, 24-32.
- Mallon, L., Broman, J.E., & Hetta, J. (2000). Relationship between insomnia, depression, and mortality: A 12-year follow-up of older adults in the community. *International Psychogeriatrics, 12*, 295-306.
- McCall, W. V., Reboussin, B. A., & Cohen, W. (2000). Subjective measurement of insomnia and quality of life in depressed inpatients. *Journal of Sleep Research, 9*, 43-48.
- McManis, M. H., Bradley, M. M., Berg, W. K., Cuthbert, B. N., & Lang, P. J. (2001). Emotional reactions in children: Verbal, physiological, and behavioral responses to affective pictures. *Psychophysiology, 38*(2), 222-231.
- Paavonen, E. J., Almqvist, F., Tamminen, T., Moilanen, I., Piha, J., Räsänen, E., & Aronen, E. T. (2002). Poor sleep and psychiatric symptoms at school: An epidemiological study. *European Child & Adolescent Psychiatry, 11*, 10-17.
- Paavonen, E. J., Aronen, E. T., Moilanen, I., Piha, J., Räsänen, E., Tamminen, T., & Almqvist, F. (2000). Sleep problems of school-aged children: A complementary view. *Acta*

- Paediatrica*, 89, 223-228 Pilcher, J. J., & Huffcutt, A. I. (1996). Effects of sleep deprivation on performance: A meta-analysis. *Sleep*, 19, 318-326.
- Shaffer, D., Fisher, P., Lucas, C., Dulcan, M., & Schwab-Stone, M. (2000). NIMH Diagnostic Interview Schedule for Children version IV (NIMH DISC-IV): description, differences from previous versions, and reliability of some common diagnoses. *Journal of the American Academy of Child & Adolescent Psychiatry* 39, 28-38.
- Sharp, C., van Goozen, S., & Goodyer, I. (2006). Children's subjective emotional reactivity to affective pictures: Gender differences and their antisocial correlates in an unselected sample of 7-11-year-olds. *Journal of Child Psychology and Psychiatry*, 47(2), 143-150.
- Soffer-Dudek, N., Sadeh, A., Dahl, R.E., & Rosenblat-Stein, S. (2011). Poor sleep quality predicts deficient emotion information processing over time in early adolescence. *Sleep*, 34, 1499-1508.
- Tempesta, D., Couyoumdjian, A., Curcio, G., Moroni, F., Marzano, C., De Gennaro, L., & Ferrara, M. (2010). Lack of sleep affects the evaluation of emotional stimuli. *Brain Research Bulletin*, 82, 104-8.
- van der Helm, E., Gujar, N., Walker, M.P. (2010). Sleep Deprivation Impairs the Accurate Recognition of Human Emotions. *Sleep*, 33, 335–42.
- Wolfe, S.M., Toro, P.A. & McCaskill, P.A. (1999). A comparison of homeless and matched housed adolescents on family environment variables. *Journal of Research on Adolescence*, 9, 53–66.
- Wood, A., Kroll, L., Moore, A. & Harrington, R. (1995). Properties of the Mood and Feelings Questionnaire in Adolescent Psychiatric Outpatients: A Research Note. *Journal of Child Psychology & Psychiatry*, 36, 327-334.
- Yoo, S., Gujar, N., Hu, P., Jolesz, F. A., & Walker, M. P. (2007). The human emotional brain without sleep—a prefrontal amygdala disconnect. *Current Biology*, 17, 877–878
- Zhang, B. & Wing Y.K. (2006). Sex Differences in Insomnia: A Meta-Analysis. *Sleep*, 29, 85-93.

Table 1. *Valence Ratings for IAPS Images in the Current Sample and a Normative Sample*

Order in Study	Picture Description	Normed Sample	Current Sample
Unpleasant Pictures			
10	Burn Victim	1.60 (1.07)	1.51 (0.89)
1	AIDS patient	2.06 (1.65)	1.93 (1.13)
6	Cemetery	3.1 (2.02)	2.41 (1.49)
3	Soldier	3.23 (2.29)	2.80 (1.76)
11	Man/Subway	3.32 (2.51)	2.19 (1.43)
Neutral Pictures			
12	Bear	4.32 (1.87)	3.85 (1.77)
13	Boy screaming	4.47 (1.78)	4.12 (1.71)
2	Fork	4.95 (1.25)	5.48 (1.64)
7	Rock climber	5.07 (1.97)	4.21 (1.65)
8	Lightning	5.19 (2.58)	4.28 (1.73)
Pleasant Pictures			
4	Ice cream	7.65 (1.92)	8.38 (1.13)
14	Sports car	7.76 (1.87)	6.64 (1.74)
9	Dolphins	7.81 (1.6)	8.33 (1.01)
15	3 puppies	7.94 (1.8)	8.40 (1.02)
5	Roller coaster	8.13 (1.64)	8.11 (1.24)

*Note:* IAPS = International Affective Picture System. Normative values based on Lang et al. (2005)

Table 2. *Hierarchical Linear Regression Model Predicting Emotional Arousal Related to Unpleasant/Negative IAPS Images*

Step	Predictor	$\beta$	$t$	$R^2$	$P$
1	Maternal Depression Status	.01	.061	.039	.951
	Age	-.20	-1.80		.075
2	Sleep Quality	-.26	-2.48	.112	.015

Note: IAPS=International Affective Pictures System