

Results presented in this chapter indicate that cycles of stress, affect, and arousal follow a diurnal pattern in adolescents. Although gender, depression risk status, and day of the week influence mean levels of adolescent moods, they are not associated with differences in mood patterns throughout the day.

Ups and Downs: Daily Cycles of Adolescent Moods

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Adolescence is a developmental period characterized by changes in all social contexts as well as dramatic individual changes, especially in physiology and cognitive capabilities (Petersen, 1987). Early adolescence can be especially challenging, given the nature, quantity, and potential synchrony of normative and nonnormative developmental transitions (Petersen, Kennedy, and Sullivan, 1991). Given the biological, psychological, and social changes accompanying the transition to adolescence, it is not surprising that a stereotyped image of adolescents as generally depressed and experiencing dramatic mood swings has pervaded the popular media, societal beliefs, and early research on adolescent affective experiences. In this chapter we examine adolescent moods from a different perspective. Temporal rhythms in adolescent moods are presented with a particular focus on daily cycles. The roles played by weekly rhythms, gender, and depressed mood in daily affective cycles are also considered.

Developmental differences in adolescent affect have been conceptualized as within-individual differences in absolute *level* of mood (more depressed or sad, on average) as well as in *changes* in mood. Much more

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research has focused on levels of adolescent moods, particularly depressed mood, than on how adolescent moods shift from hour to hour (Buchanan, Eccles, and Becker, 1992; Petersen and others, 1993). In the research focusing on level of mood, overall mood has been found to be more negative for adolescents than for either preadolescents or adults (Larson and Lampman-Petrattus, 1989; Larson and others, 1990; Petersen and others, 1993; Petersen and Leffert, 1995). Some have found that increased negative mood in adolescence may be due in part to situational factors, such as an increase or "pileup" of stressful events in adolescence (Ge, Lorenz, Conger, and Simms, 1994; Larson and Ham, 1993; Petersen, Sarigiani, and Kennedy, 1991; Simons and Blyth, 1987).

Given the pervasive belief that adolescents are moody, it is surprising that most research has examined developmental differences in *level* of mood and not differences in pace, magnitude, or pattern of mood *changes* within a day. The limited research that has been conducted on mood shifts has focused on variability (using measures that combine quickness of change and range of emotion) and has neglected to consider temporal patterns (direction of rise or fall throughout the day). In this chapter we focus on daily patterns of mood change in adolescence.

Because almost nothing is known about young adolescents in this area, we begin by summarizing the evidence for endogenous patterns of mood change in adults. By considering the diurnal patterns of mood change typical in adulthood, we highlight the need to study similar diurnal patterns in adolescence. We then present data on average daily patterns of mood shifts for young adolescents to illustrate that mood shifts in adolescence parallel adult diurnal cycles. Finally, the chapter concludes with a discussion of the implications of these daily rhythms for optimal adolescent experiences.

Patterns of Mood Change

Research on changes in adolescent moods has focused primarily on mood variability from week to week, and therefore little is known about daily patterns of adolescent moods (for an exception, see Csikszentmihalyi and Larson, 1984). Research with adults has examined mood patterns along two time dimensions: social time (calendar week) and body time (circadian rhythm, menstrual cycle). This research has found that fluctuations in positive affect (joy, energy level, alertness, interest) are related to both natural and socially determined rhythms, including season of the year, day of the week, time of day, and menstrual cycle phase (Clark, Watson, and Leeka, 1989; Rossi and Rossi, 1977; Smith, 1979; Stone, Hedges, Neale, and Satin, 1985).

Weekly Mood Patterns. Socially determined temporal rhythms include patterns that are based on the calendar. For example, mood differences related to school and holiday schedules or weekday and weekend schedules are likely to be a reflection of the divergent contexts and activities experienced by an individual at various times in his or her social calendar. Day of the week has

been shown to have a strong effect on level of mood. The most consistent finding across studies is that adults and high school-age adolescents experience more positive and less negative moods on weekends than they do on weekdays (see Chapter Three; Rossi and Rossi, 1977; Stone, Hedges, Neale, and Satin, 1985). This pattern, in which positive affect peaks on the weekend, has not been found among young adolescents (see Chapter Three).

Diurnal Variations in Mood. Biological rhythms include those cycles that are subject to endogenous control by an individual's body clock. Hormone secretion, for example, follows a diurnal cycle. Biologically based approaches to the study of adolescent moods have focused on mood-hormone connections during puberty. Because research has linked between-person differences in adolescent affect to hormone levels (Susman, Dorn, and Chrousos, 1991; Susman and others, 1987), we might also expect to find that daily within-person cycles of mood parallel circadian rhythms in hormone secretion.

Although we know little about diurnal patterns in adolescents' moods, research examining adult mood changes over the course of a day has generally found that positive affect and alertness or arousal rise to a peak during the day and decline during the evening, resulting in an inverted U pattern (Caminada and DeBrujin, 1992; Clark, Watson, and Leeka, 1989; McNeil, Stones, Kosma, and Andres, 1994; Stone and others, 1994). Chronobiological discussions of diurnal variation compare moment-to-moment feelings of positive affect to alertness or performance, the latter having been shown to undergo an endogenous circadian rhythm (Haug and Wirz-Justice, 1993). Thus adult ratings of positive affect (both physical and cognitive aspects) have a diurnal pattern that parallels physiologically based circadian rhythms in measures such as hormonal secretion and body temperature (Clark, Watson, and Leeka, 1989). This congruence suggests that positive affect may represent one aspect of a complex system with both psychological and biological components.

However, diurnal patterns are not consistent across all types of moods. Fluctuations in negative affect, including subjective distress and stress, do not consistently follow a stable or predictable diurnal pattern, suggesting greater susceptibility to contextual influences (Clark, Watson, and Leeka, 1989; Watts, Cox, and Robson, 1983). If negative moods are more responsive to exogenous factors than are positive moods, then rather than following a daily pattern that parallels biological rhythms, they could be expected to relate to occurrence of daily stresses and hassles.

Individual differences in adult diurnal cycles of mood have been examined for a number of factors. The inverted U shape of diurnal patterns in positive mood and arousal among adults has been found to be invariant across gender (Caminada and DeBrujin, 1992), age groups (McNeil, Stones, Kosma, and Andres, 1994), depression status (Clark, Watson, and Leeka, 1989), and personality type (for example, introversion and neuroticism; Clark, Watson, and Leeka, 1989). Diurnal type, based on self-reports of whether one is a morning or an evening person (described as "morningness-eveningness" in the literature),

has been the most promising characteristic in predicting differences in diurnal patterns in adults (Caminada and DeBruijn, 1992; Watts, Cox, and Robson, 1983). Interactions between time of day and diurnal type have indicated that the diurnal mood patterns of morning types peak earlier than those of evening types. However, not all studies have found an effect of morningness-eveningness on diurnal patterns (Clark, Watson, and Leeka, 1989).

Despite the consistent evidence for diurnal cycles in adult moods, we know little about daily patterns of mood change in adolescence or about whether there are individual or social factors that are related to those daily patterns. The youngest participants in studies of daily mood patterns are generally college students. No research has examined the pattern of young adolescents' moods within a day or investigated whether social time (day of the week) moderates such patterns. Furthermore, the role of gender and depression risk status in daily mood cycles is unknown. Because depression and depressed mood increase in adolescence, and adolescent girls report greater increases in depression than do adolescent boys (Petersen and others, 1993), it is important to consider whether the characteristics of gender and depression predict differences in cycles of adolescent moods. In this study we consider whether diurnal patterns can be found in early adolescence, and if so, whether mood patterns within a day vary depending on the gender of the reporter, his or her depression risk status, the day of the week, and the type of mood being assessed.

The Penn State Adolescent Study of Diurnal Mood Patterns

In this chapter we use data from the Penn State Adolescent Study to look at how affect, arousal, and stress vary across the day. Subjects for these analyses were 162 seventh-grade students from two different communities in Pennsylvania who were part of a larger cohort-sequential longitudinal study designed to determine the relationship among changes in adjustment, puberty, and coping (Petersen and others, 1997). The sample was composed primarily of European American adolescents, with roughly equal numbers of boys (seventy-seven) and girls (eighty-five). Approximately half of the adolescents in the study participated in a psychoeducational intervention program designed to teach them adaptive coping responses to stressors or challenges. Subjects were predominantly from lower-middle- to middle-class backgrounds.

We used a procedure called the Experience Sampling Method (ESM) to measure adolescent moods across the day. The ESM has been extensively reviewed elsewhere (Csikszentmihalyi and Larson, 1987; Larson, 1989) and is considered one of the best methods for sampling the daily and hourly experiences of adolescents. Participants in this study provided reports on their emotions, activities, and companions at random times during the day, whenever they were signaled. Subjects received seven signals per day (six on the first day),

from 7:30 A.M. to 9:30 P.M. on weekdays and from 8:30 A.M. to 10:30 P.M. on weekends. Subjects also filled out the same reports daily when they awoke and before they went to bed, resulting in a total of nine reports each day. Subjects were studied over the course of one week, from Monday to Sunday, in the winter of their seventh-grade school year. For the purpose of the present analyses we averaged reports for each individual to form four time periods: early morning (waking report and signals 1 and 2), late morning-early afternoon (signals 3 and 4), late afternoon-early evening (signals 5 and 6), and evening (signal 7 and the before-bed report). The average response rate for the combined reports was 85.8 percent, representing twenty-four of the twenty-eight time periods.

Adolescent emotional state was measured by having the participants fill out a self-report in a log book whenever they were signaled and upon arising and before going to bed. Our analyses include ratings of six different variables: unhappy-happy, irritable-cheerful, angry-friendly, drowsy-alert, weak-strong, and relaxed-stressed. Because we wanted to distinguish between affect, arousal, and stress, the first three variables were combined into a single affect variable ($\alpha = .89$), with higher scores representing more positive affect. The next two variables were also combined into an arousal variable ($\alpha = .80$), with higher scores indicating greater arousal. Finally, relaxed-stressed was used as the third variable, with higher levels representing greater stress.

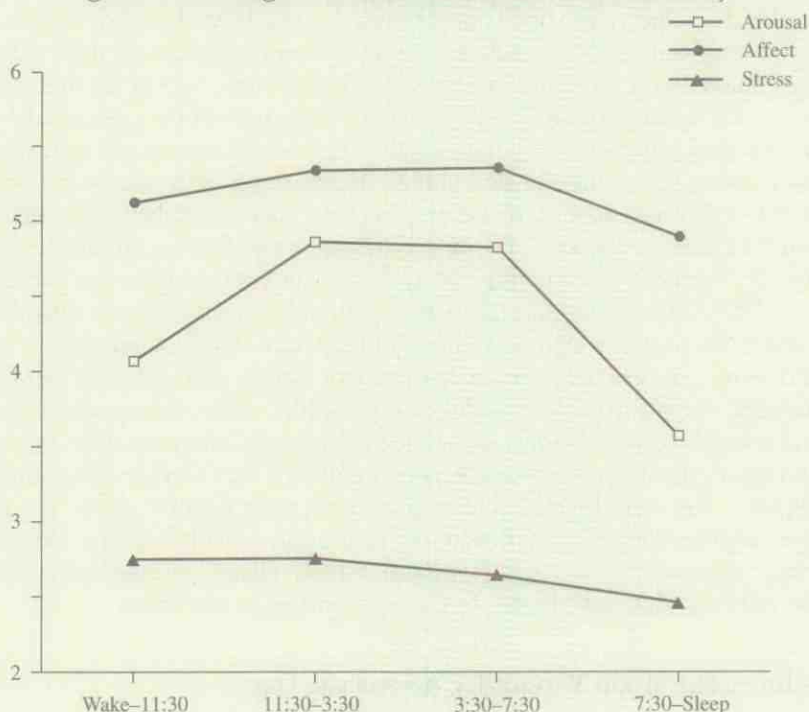
Adolescent Mood Variability Across the Day

We examined whether the daily cycle of adolescent moods across the day followed a diurnal pattern similar to that found in research on adults. Adult reports of diurnal mood patterns have indicated that positive mood rises in the morning and declines in the evening, and this pattern has been found in both physical (alert) and affective (enthusiastic) dimensions of positive affect (Clark, Watson, and Leeka, 1989). Measures of negative affect, such as stress and anxiety, have not been found to follow this diurnal pattern in adult samples (Clark, Watson, and Leeka, 1989; Watts, Cox, and Robson, 1983).

To test whether patterns of adolescent moods differed depending on the specific mood, we ran repeated measures analyses using both time of day and type of mood as predictors. Figure 2.1 shows the patterns of adolescent moods across the day. Results from our analyses revealed a significant interaction between time of day and type of mood, $F(6, 960) = 53.2, p < .001$, suggesting that the overall diurnal pattern of adolescent moods is different for the three types of moods: arousal, affect, and stress.

Separate univariate analyses showed that, as expected, levels of arousal rose from early morning to a peak during late morning-early afternoon and late afternoon-early evening before falling to the lowest level during late evening. The quadratic effect of time for arousal was significant, $F(1, 160) = 276.4, p < .001$. A similar pattern was found for adolescent affect, with feelings of happiness, cheerfulness, and friendliness rising from early morning to peak during late morning-early afternoon and late afternoon-early evening

Figure 2.1. Change in Adolescent Moods Across the Day



before falling to the lowest level during late evening. The quadratic effect of time for adolescent affect was also significant, $F(1, 161) = 103.6, p < .001$.

In contrast, the pattern of change across the day appeared to be different for adolescents' reports of stress. Although the quadratic effect for stress was also significant, $F(1, 161) = 5.0, p < .03$, examination of the means revealed that the pattern of change across the day differed from the patterns found for adolescent arousal and positive affect. For adolescents, stress levels were relatively high during early morning and during late morning-early afternoon and then decreased steadily throughout the rest of the day, with the lowest levels of stress reported during the late evening (Figure 2.1). It should also be noted that differences in stress levels across the day were small, typically less than one-quarter of a standard deviation.

To determine whether the pattern of adolescent mood changes across the day differed depending on type of mood, we conducted an additional series of follow-up comparisons. Results from these comparisons of the multivariate analyses revealed that the diurnal pattern (that is, the quadratic effect of time) was, in fact, different for each of the three moods. The quadratic effect of time for adolescent arousal was stronger than the quadratic effect of time for both adolescent affect, $F(1, 160) = 165.7, p < .001$, and adolescent stress,

$F(1, 160) = 150.5, p < .001$. Furthermore, adolescent affect followed a more pronounced diurnal pattern (that is, a stronger quadratic effect of time) than did adolescent stress, $F(1, 161) = 14.8, p < .001$. Thus our results appear to be consistent with findings from research on adult mood variability. Measures of adolescent arousal showed the strongest inverted-U-shaped diurnal pattern (which parallels other biological rhythms): starting low during the early morning, rising to a peak during the middle of the day, and then falling to a low during the late evening. Adolescent affect showed a similar pattern, but the midday peak was less pronounced. Finally, adolescent stress did not show the same diurnal patterning as adolescent arousal or adolescent affect. Although levels of adolescent stress showed a quadratic effect of time, they peaked very early in the day and then steadily decreased throughout the rest of the day.

Mean Level of Mood by Gender and Depression Risk Status

We next ran a series of repeated measures analyses that examined whether mean level of mood in adolescents differed for boys and girls, by depression risk status, or by a combination of gender and risk status. Adolescents were considered to be at risk for depression if they reported being in the upper third of the distribution for depressive mood in the fall of both the sixth and seventh grades (Petersen and others, 1997).

No main effects of gender were found for either adolescent arousal or adolescent stress. However, a main effect of gender was found for adolescent affect, $F(1, 157) = 7.15, p < .008$, with girls reporting more positive affect overall than boys. Although this finding is consistent with previous research done using beeper data (for example, Larson and Lampman-Petrattus, 1989), it is inconsistent with other developmental research, which typically finds that adolescent girls are more likely to report depressed mood than are adolescent boys (Petersen and others, 1993). The reversal of the typical pattern for girls may be attributable to the method used to collect the data. In this study the response to the signal indicates how an individual is feeling at that moment, or her short-term mood state. In studies of depressed mood, respondents are often asked to report retrospectively for a long period (such as the previous six months). Males and females may have different styles in answering this type of question, with females more likely to ruminate on depressed mood (Nolen-Hoeksema, 1987) and therefore amplify distress-provoking events when they mentally calculate their long-term composite. Further research is needed to examine the relationship between short-term mood state (as assessed by the beeper method) and reports of depressed mood. Alternatively, the seventh-grade participants in our study are at a developmental point at which the gender distribution of depression is reversing. In childhood, the prevalence of depression is higher for boys than for girls, but by middle ado-

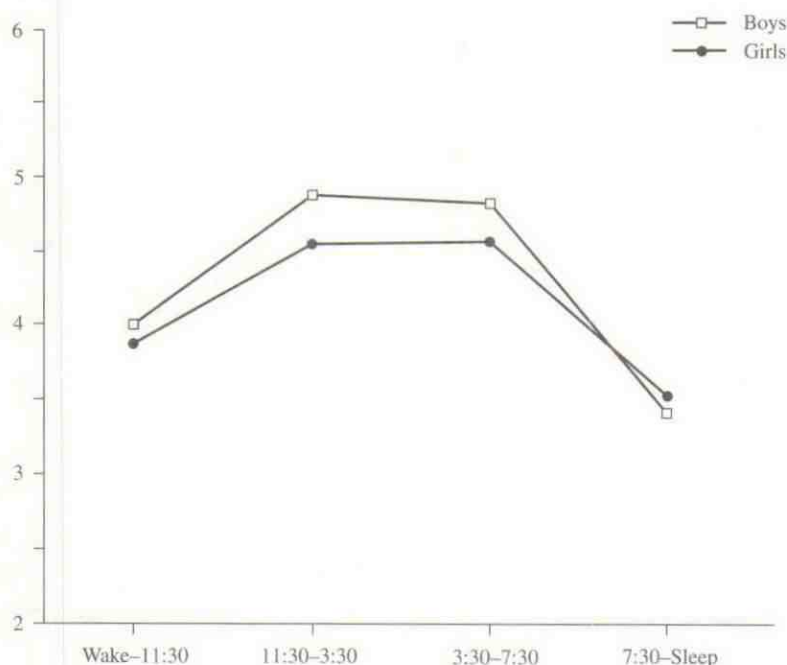
lescence and into adulthood, the rates of depression are higher for females (Petersen and others, 1991).

We also found main effects of depression risk status for all three mood indicators. Adolescents who were identified as being at risk for depression reported significantly lower mean levels of arousal, $F(1, 156) = 14.2, p < .001$; less positive affect, $F(1, 157) = 16.8, p < .001$; and higher mean levels of stress, $F(1, 157) = 5.9, p < .02$, than did adolescents who were not at risk for depression. Our results concerning the main effects of depression risk status on adolescent mean level of mood are consistent with other research, which has shown that depressed youth report lower levels of energy and positive affect and higher levels of negative affect than do nondepressed youths (Larson and others, 1990; Petersen and others, 1993). No interactions between gender and risk status were found for any of the three moods.

Patterns of Adolescent Mood Variability by Gender and Depression Risk Status

We also ran repeated measures analyses to determine whether temporal patterns of adolescent mood variability differed for boys and girls, by depression risk status, or by a combination of both gender and depression risk status. Interestingly, although our earlier analyses had indicated that both gender and depression risk status contributed to differences in mean levels of adolescent moods, the present analyses found little indication that the diurnal patterns of adolescent mood change were moderated by gender or depression risk status. Only one interaction between gender and time was found, for adolescent arousal, $F(3, 468) = 2.6, p < .05$. Figure 2.2 shows the pattern of adolescent arousal across the day for boys and girls separately. As can be seen from the figure, both boys and girls showed similar diurnal patterns of arousal. The gender difference appears to be in the speed of acceleration and deceleration of arousal, as well as in the peak level of arousal. Level of arousal in boys both accelerates and decelerates more quickly than it does in girls. Furthermore, boys reach a higher peak level of arousal than do girls. The diurnal patterning (that is, quadratic effect of time) difference between boys and girls approached significance, $F(1, 156) = 3.7, p < .06$. No interactions between depression risk status and time were found for either adolescent arousal, affect, or stress. Finally, there were no three-way interactions between time of day, gender, and risk status for any of the three mood variables. Results from these analyses suggest that, although overall mean levels of adolescent moods vary by depression risk status and, to a degree, gender, diurnal patterns of mood change throughout the day are similar for boys and girls and for depressed and nondepressed adolescents. Results from the current set of analyses are consistent with research on diurnal patterns in adult moods. The U-shaped patterns of diurnal variation in adult positive mood and arousal are consistent across both gender (for example, see Caminada and DeBrujin, 1992) and depression status (see Clark, Watson, and Leeka, 1989).

Figure 2.2. Gender Differences in Patterns of Arousal



The Clock and the Calendar

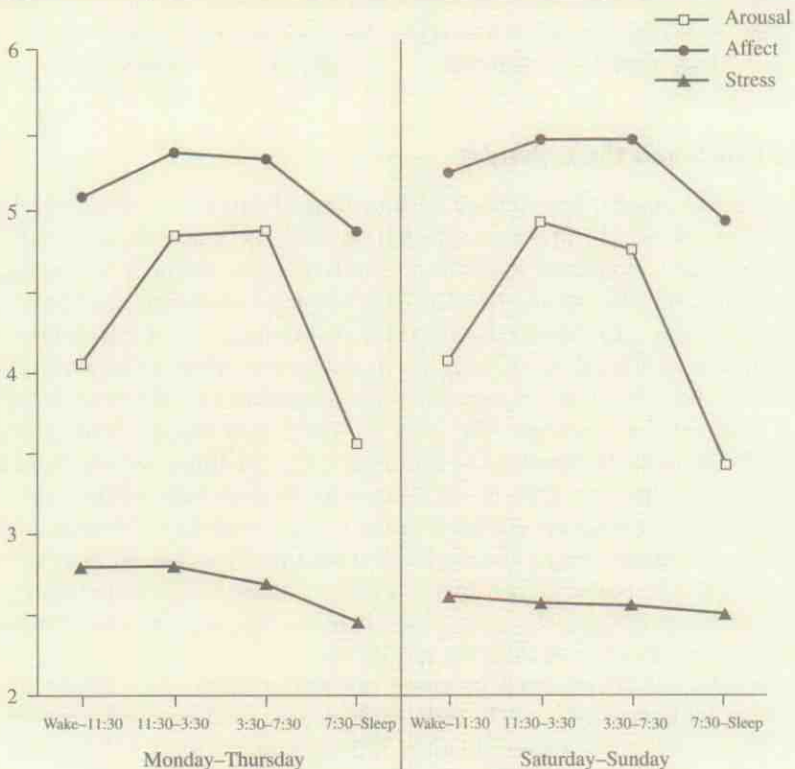
Thus far this chapter has focused on how time of day, or the clock, is related to adolescent moods. Previous research on adolescent moods, however, has examined how adolescent mood level is related to the calendar (for example, day of the week and social calendars). Although an examination of how time of day interacts with the social context is beyond the scope of this chapter, we did run an additional set of analyses to determine whether mean levels of mood and patterns of mood variability in adolescents were different on weekdays than on the weekend. We used the combined reports from Monday through Thursday to represent weekdays and the combined reports from Saturday and Sunday to represent weekend days. Reports from Friday were not included, as Friday is conceptually similar to both weekdays (because adolescents are in school during the day) and weekends (because adolescents are more likely to be out with their friends Friday evenings).² Due to reduced sample sizes, it was not possible to conduct these analyses separately for boys and girls or for adolescents in different risk groups.

Analyses of mean levels of mood revealed a main effect of day of the week for adolescent affect, $F(1, 160) = 5.6, p < .02$, and for adolescent stress, $F(1, 161) = 4.2, p < .04$. Examination of the means revealed that adolescents

are both happier and less stressed on weekends than they are on weekdays. These results are consistent with results found by other researchers (see Chapter Six), in that adolescent mood is generally more positive during the weekend than on weekdays. We did not find a main effect of day of the week for mean level of adolescent arousal, indicating that adolescents are no more or less alert on weekend days than they are on weekdays. Thus our results support the idea that moods differ in the extent to which they are responsive to exogenous factors (such as day of the week), because mean level of adolescent arousal is less likely to vary from day to day than are mean levels of adolescent affect or stress.

Diurnal patterns of adolescent moods for weekends and weekdays are shown in Figure 2.3. As can be seen from the figure, daily cycles of adolescent moods appear to be remarkably similar during the week and on weekends. Results from our analyses confirm this impression. No significant interactions between day of the week and time of day were found for either adolescent affect or adolescent arousal, indicating that the daily pattern of change in these two moods is similar on weekends and weekdays. However, we did find a significant interaction between time and day of the week for adolescent stress,

Figure 2.3. Cycles of Adolescent Moods on Weekdays and Weekends



$F(3, 483) = 2.9, p < .03$. Results from follow-up analyses of the temporal patterns of adolescent stress suggest that the pattern of change across the day differs on weekdays and weekends. During the week adolescent stress starts out high during the early morning and late morning-early afternoon and then declines throughout the rest of the day. Both the linear and quadratic effects of time were significant: $F(1, 161) = 23.5, p < .001$, and $F(1, 161) = 4.3, p < .04$, respectively. In contrast, adolescent stress does not vary in either a linear or a curvilinear way on weekends, indicating that adolescents report a constant level of stress across the day on weekends.

Thus on one hand, results from these analyses are consistent with the hypothesis that the daily cycle of negative mood in adolescents is more susceptible to exogenous factors, such as calendar time or social context. On the other hand, the finding that diurnal patterns of adolescent affect and arousal are consistent across weekdays and weekends might suggest a biological component of affect and arousal that is not overridden by social factors at this age.

Implications and Future Directions

The primary finding from the study described here is that, overall, adolescent mood follows predictable diurnal patterns across the day. However, depending on the type of mood examined, the patterns vary in the extent to which they conform to an inverted U shape. Specifically, adolescent arousal and adolescent affect follow inverted-U-shaped diurnal patterns, with levels of arousal and affect starting low in the early morning, rising to a peak from the late morning through the early evening, and then falling in the late evening. Adolescent stress, on the other hand, starts out high in the early morning and then steadily declines throughout the day and evening. Furthermore, although mean level of adolescent affect and arousal varies by gender, depression risk status, and day of the week, the diurnal pattern of these two adolescent moods is invariant across these individual and social factors. In contrast, both mean level and daily pattern of adolescent stress appear to be influenced by day of the week.

These patterns parallel findings from adult samples, and like the literature on adults, they suggest that arousal and positive affect may cycle in concert with other endogenous circadian rhythms. For example, the secretion of cortisol follows a diurnal rhythm, peaking in the early morning and dropping in the afternoon (Sacher, 1985). Could daily cycles in hormone secretion influence adolescent moods? Evidence from interindividual comparisons suggests it is possible. Susman and her colleagues (Susman, Dorn, and Chrousos, 1991; Susman and others, 1987) found that, consistent with the psychoneuroendocrinology of adults, adolescent affect was related to individual differences in hormone levels. In particular, higher cortisol levels were related to higher depression scores.

What is the importance of considering endogenous, or biological, cycles in adolescent moods? Clearly such patterns have implications for both research and policy. First, research focusing on levels of adolescent moods should survey adolescents at a consistent time of day, perhaps even on a consistent day

of the week, to control for the potentially confounding effects of biology and social time on mood. For example, if cross-sectional data are collected from adolescents in the morning and from preadolescents in the afternoon, a diurnal pattern might enhance or mask any age difference.

In addition, researchers focusing on exogenous factors related to differences in adolescent moods should take into account potentially biologically based hourly variations in mood. For example, Larson and colleagues have documented that mean levels of adolescent moods vary by social context. Specifically, adolescents reported more positive mood when with friends than when with family (Larson, 1983; Larson and Asmussen, 1991). Furthermore, adolescents reported more positive mood when away from home and when engaged in leisure activities (Larson and Richards, 1994). Clearly our results from the day of week comparisons are consistent with the notion that the socially determined calendar influences adolescent moods, in that adolescents report more positive mean levels of affect and lower mean levels of stress on weekends than they do during the week (although there are no day of the week effects for mean level of adolescent arousal). However, our results also indicate that the diurnal *pattern* of affect and arousal in young adolescents does not vary from weekdays to weekends, suggesting an invariant, biological influence on the daily *cycle* of adolescent moods. Because young adolescents are less likely to be with friends, to be away from home, and to be engaged in active leisure activities during the early morning and late evening, when levels of positive affect and arousal are low, it is possible that some of the social context differences found in other studies were confounded by endogenous diurnal patterns of adolescent mood change. Thus studies that examine the independent and interactive effects of both social context and time of day are needed.

Finally, our findings have potential implications for policymakers and researchers investigating school achievement. Given that levels of arousal are lower, affect is less positive, and stress levels are higher during the early morning period for young adolescents, school administrators might consider planning the school day accordingly. For example, the school day could start later, allowing adolescents to reach a higher level of alertness prior to their starting classes. Alternatively, difficult subjects requiring more intense concentration could be offered during peak arousal times, that is, in the late morning and early afternoon.

Are adolescents' moods similar to those of other age groups? Our research suggests that adolescents' diurnal mood patterns parallel those of adults. Although some research suggests that the levels of mood experienced by adolescents may be more extreme than those of younger and older age groups, our results suggest that adolescents do not appear to manifest different daily cycles of moods.

Notes

1. There were 335 adolescents in the entire sample. To be included in the present analyses, adolescents needed to have responded to at least one beep during each of the four composite time periods during the week (Monday through Thursday) and to at least one beep during

the four composite time periods during the weekend (Saturday and Sunday). Approximately half ($n = 173$) of the adolescents in this sample failed to meet the criteria and were excluded from the analyses presented in this chapter. However, analyses of daily cycles of adolescent moods were repeated using the entire sample, and the results from those analyses did not differ from the results presented here.

2. Analyses (not presented here) compared both the mean levels and the daily patterns of mood change on Friday with both the mean levels and the daily patterns of mood change Monday through Thursday and on the weekend. The mean levels and daily cycles of adolescent moods on Friday were not significantly different from the mean levels and daily cycles of adolescent moods on Monday through Thursday or on the weekend.

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