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RHYTHMIC VARIATIONS OF MOOD

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Abstract

In this article, an overview of studies on circadian (daily), circaseptan (weekly) and circannual (yearly) variations of positive affect, negative affect and total mood is given. Studies on circadian mood rhythms, which were mostly focused on fluctuations of positive and negative affect, indicate that positive affect displays circadian variations, while negative affect does not. Such findings are linked to predictive and reactive homeostasis, respectively. The function of positive affect could be to energize the organism to be more active during the middle of the day, while the function of negative affect could be to respond to immediate threats which can appear during any time of the day. Research on circaseptan mood rhythms often also explored total mood in addition to positive and negative affect. Current findings show that mood is higher during the weekend than during the working week. It is possible that such variations are culturally determined, however, more research is needed to reach stable conclusions. Studies on circannual mood rhythms were mostly focused on seasonal affective disorder (SAD). SAD rates are highest in the winter, although a smaller number of patients report depressive symptoms during the summer months. Predictive homeostasis is also thought to be the underlying evolved mechanism responsible for SAD since SAD makes the organism less active, thus reducing the quantity of food the organism needs to consume in the winter months when the sources of food are scarce. An overview of differences between yearly fluctuations of SAD rates and suicide rates is given.

KEYWORDS: affect, circadian clocks, circaseptan, periodicity, seasonal mood disorder

INTRODUCTION

In psychological science, mood is a construct which is, along with emotions, encompassed within a broader term called *affect*. Although all intrapsychical processes are interlaced, affects are distinct from cognitive (e.g. thinking, perception) and conative (e.g. personality traits) constructs because they possess a subjective component. In other words, affects are composed of characteristic "feelings" that can be experienced only from the first-person perspective and are difficult to verbalize or explain to other persons. This subjective quality is mutually shared between emotions and mood.

MOOD AND EMOTIONS

Mood is, however, distinct from emotions in several important characteristics. Firstly, emotions are more intensive than mood. Both measures of subjective feelings and measures of physiological reactions clearly show that emotions elicit stronger psychological and physiological reactions than mood. Secondly, emotions are triggered by significant life events, while the determinants of mood are more dispersed and are less likely to be known by the person experiencing the affective state. For example, a person may become frightened because of the imminent danger which poses a threat to his/her well-being, sad because of a loss of a loved one, angry because another person usurped his rightful interests. On the other hand, a person may be in a bad mood throughout the day without clear reasons for such mood and the reasons may even be unknown to the person experiencing the described mood. Thirdly, emotions are of shorter duration than mood. While emotions are usually quick to appear and fade, the duration of mood is significantly longer. Modern research shows that, unlike emotions, mood actually never ceases to be present and can be felt in any moment from the first-person perspective.[1]

Research has shown that mood consists of two separate dimensions: positive and negative affect. Positive affect is characterized by pleasant, happy, joyful and energized mood, while negative affect is characterized by unpleasant feelings of subtle anger, fear, sadness and anxiety. The finding that these two dimensions are separate was unusual to many laypeople and scientists alike because the conventional viewpoint held that the positive and negative affect are two

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poles of the same continuum.[2] At first, researchers insisted that the positive and negative affect are two completely separate, orthogonal dimensions. However, newer studies have shown that, while these two dimensions indeed are separate, they are not completely distinct, but are instead in a low-to-moderate negative correlation. Thus, these two dimensions are sometimes referred to as *quasiorthogonal*.[3] Some self-report instruments for measurement of mood have separate measures for positive and negative affect and the measure of "total affect" is mathematically calculated as the difference between positive and negative affect.[2] Apart from self-report inventories, behavioral indicators can also be used as a measure of a person's current mood. For example, laughter and sobbing are reliable indicators of positive and negative affect, respectively. However, studies that have used behavioral indicators as a measure of mood are rare, because the data collection process is difficult and time-consuming. Recently, there have been developments in implicit measurements of mood (e.g. a person is asked to rate the emotional valence of non-existent words). While the results of the first validation studies were promising, more studies are needed to fully validate this type of measure, which is why implicit mood measures have not yet been used in other studies besides the validation studies.[4]

TYPES OF RHYTHMIC VARIATIONS OF MOOD

Given the fact that mood is a constant state which never disappears from the intrapsychical world of each person, researchers have turned their interests to the fluctuations of mood in time. Biology has shown that many processes in the human body show daily (circadian), weekly (circaseptan), monthly (circalunar) or yearly (circannual) rhythmicity. Perhaps the most cited example of a rhythm is the sleep-wakefulness rhythm which exhibits a clear circadian rhythm.[5] Some other examples include body temperature[6] and height,[7] which exhibit a circadian rhythm; synthetization of certain substances in the immune system,[8] which exhibits a circaseptan rhythm; menstrual cycle,[9] which is perhaps the most famous example of a circalunar rhythm and testosterone production in males, which shows both circadian[10] and circannual11 fluctuations.

CIRCADIAN RHYTHMS OF MOOD

The greatest number of studies examining rhythmic fluctuations of mood were oriented on investigating circadian mood variability. Most studies examined either positive and negative affect separately, or only examined one of these two dimensions, while a smaller number of studies examined the variability of total affect. Studies of positive affect revealed that it exhibits clear circadian fluctuations, appearing to be low in the mornings and evenings and reaching its peak during afternoon hours. This conclusion was reached by virtually all studies investigating circadian rhythms of positive affect.[3,12-18] Modern theories hold that the circadian rhythmicity of positive affect is endogenous and such variations are linked with predictive homeostasis. Homeostasis is an umbrella term for a group of biological functions whose purpose is to maintain the balance of the level of certain characteristics of the organism (e.g. to maintain the optimal body temperature by sweating if the temperature is too high or by shivering if the temperature is too low). It can be divided into two types: reactive homeostasis, which aims to restore the balance after it has been disrupted and predictive homeostasis, which aims to alter the state of an organism in anticipation of an event that can disrupt the balance so that the balance doesn't get disrupted once the event occurs.[19] Studies in evolutionary psychology have shown that the evolutionary function of happiness is to motivate the organism to approach potentially rewarding stimuli.[20] The idea of a prospective experience of a pleasant emotional state after completing a certain behavior motivates the organism to take part in said behavior. Moreover, the experience of a pleasant emotional state after completing a certain behavior keeps the prospective expectation realistic and relevant. Since humans are a diurnal species, the potential function of circadian variations of positive affect is to motivate the organism to be active during the daytime, when the opportunities for finding positive stimuli are the greatest, and less active during mornings and evenings.[3,14,21] There is currently no known methodology which could be applied to measure mood while the organism is sleeping. However, evolutionary psychologists have also devised a hypothesis which holds that the evolutionary functions of sleep is to force the organism to be inactive during the nighttime, when the opportunities for finding useful objects are lesser.[19] In other words, the functions of circadian rhythmicity of positive affect and sleep-wakefulness cycles are mutually adverse. Because of this, certain authors believe that deep sleep represents the nadir of the daily fluctuation of positive affect; it is its lowpoint that currently cannot be measured.[21]

Studies of negative affect, on the other hand, show that negative affect displays no circadian fluctuations. This finding was replicated in many studies.[3,12,14,17] Certain studies have detected circadian rhythmicity in negative affect, but they have found that the rhythm of negative affect is much less prominent than the rhythm of positive affect,13 or that the goodness-of-fit measures indicate that the detection of a significant circadian rhythm of negative affect could be a statistical artifact.[18] Modern theorists rely on evolutionary functions of emotions to explain these findings. Many negative emotional states (e.g. fear, anger) temporarily raise the activation level of an organism to allow for more efficient behavioral coping with threatening or unfriendly stimuli. Fear can mobilize the energy of the organism for faster escape or more efficient defense against an attacker. Anger can also mobilize the energy and allow the organism to attack other hostile organisms. Since it is unpredictable when the need for such mobilization of organism will occur (e.g. dangerous animals can also attack in the morning), negative affect needs to be more flexible and ready for activation at any time of the day, which is why the function of the variations of negative affect is linked to reactive homeostasis.[3,22] For this reason, negative affect displays no circadian variations and the rhythmicity of negative affect is thought to be exogenous rather than endogenous. While mood is usually measured through self-report inventories, some studies that have used behavioral indicators to measure mood have also concluded that positive affect exhibits circadian variations, while negative affect does not. For example, it was found that people laugh mostly during the middle of the day, with less laughs in the mornings and evenings, while the frequency of sighing

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does not depend on the time of the day.[23]
Studies of circadian variation of total affect are rare. In one study it was found that total affect displays a circadian rhythm in a similar manner to positive affect; the peaks of total affect coincided with the peaks of positive affect. However, being composed of both positive and negative affect, total affect displayed greater deviations from sinusoidality than positive affect and the rhythm was much less prominent. It was also found that the extraversion/introversion personality trait may have an impact on the sinusoidality of total affect. While a significant circadian rhythm was found in introverts, it was not found in extraverts, which may be explained with the known findings that extraverts are more prone to sensation-seeking behaviors, which may result in outcomes that unsystematically impact the mood of extraverts and make their mood rhythm less sinusoidal. Such differences between extraverts and introverts were not found in positive affect, which is why future studies should focus on investigating differences in the exogenous fluctuations of negative affect between these two groups.[18]

Disruptions in circadian mood rhythms are also linked to the personality trait of neuroticism. One study found that the people with high results on measures of neuroticism did not display a circadian rhythm of positive affect, while those who scored lower did display such a rhythm[24]. It is interesting that the group with high results on neuroticism measures also displayed a weaker amplitude of circadian rhythm of body temperature, which suggests that the general circadian rhythmicity may be lower as neuroticism increases.24 Some of the yet unverified explanations hypothesize that lower levels of gamma-aminobutyric acid (GABA) lead to disruption of activity in suprachiasmatic nucleus, which is responsible for regulating circadian rhythms.[24] Lower levels of GABA are also found in depressed patients. It is also known that GABA is one of the essential neurotransmitters that induce sleep, which is why disruptions in mood may be linked with disruptions in the sleep-wakefulness cycle.[24] This similarity in disturbances between circadian mood rhythms and circadian sleep-wakefulness rhythms provides further support for the hypothesis that these two regulatory mechanisms are two sides of the same coin that regulates the activation level of an organism (Figure 1).

CIRCASEPTAN RHYTHMS OF MOOD

A smaller number of studies investigated how mood varies on a weekly basis. Initial results showed that total affect [13,25] and positive[16] and negative[13] affect display a circaseptan rhythm, with total affect and positive affect being higher during the weekend and lower during the working week, while negative affect displayed an opposite trend. Differences between introverts and extraverts were also found, with the same trend of results as in circadian rhythms. Rhythm of total affect was more pronounced in introverts than in extraverts.[25] But, from a general viewpoint, the number of studies of circaseptan mood rhythms was small and theoretical debates about the causes of such rhythmicity emerged. The proponents of the cultural viewpoint argued that the circaseptan variations of mood are determined by the structure of the week. Since people are preoccupied by obligations during the working week, their mood is lower and since they are relatively free during the weekends, they have the ability to engage in activities they find interesting and joyful, which is why their mood is increased on weekends. On the other hand, theorists who favored a biological viewpoint insisted that the circaseptan variations of mood are innate and endogenous. The support for this argument was found in the results of certain chronobiological studies which found that some non-psychological variables, such as the number of erythrocytes[26] and the response of the immune system to endotoxins[27], also display a circaseptan rhythm. The structure of the week, according to these theorists, was not a determinant of the mood. Instead, the structure of the week itself was determined by innate circaseptan variations.[25]
One study,[28] although its sample size was small, was conducted to test which of these two opposing viewpoints is true. In this research, mood was measured using a self-report inventory each day in November, when the structure of the week is clear

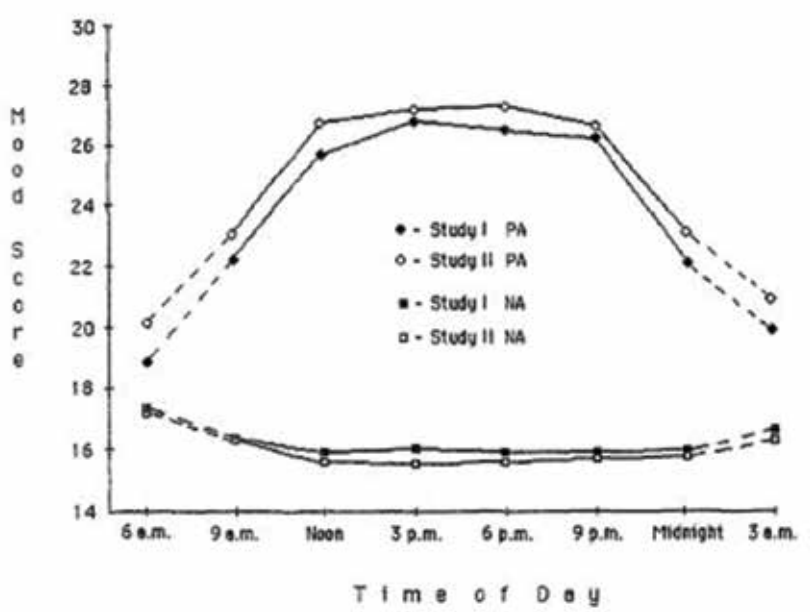

Figure 1. Diurnal pattern of Positive Affect (PA) and Negative Affect (NA) in Studies I and II.
Source: Clark LA, Watson D, Leeka J. Diurnal variation in the Positive Affects. Motiv Emot. 1989;13(3):205-234. doi:10.1007/BF00995536.

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and in July, when the differences between the working week and the weekend are much less pronounced. The results of this research showed that mood, as was expected, exhibited a circaseptan rhythm in November, but did not exhibit a circaseptan rhythm in July. These findings suggest that the circaseptan variations of mood are not innate, which is in concordance with the cultural viewpoint and is aligned with the fact that there is no external marker which would mark the passing of a week and which would allow circaseptan rhythmicity to appear in humans through natural selection. There are potentially important clinical implications of these results. It is possible that the aforementioned circaseptan rhythmicity of non-psychological variables is in fact influenced by variations of mood. In other words, it is possible that those circaseptan variations are also not endogenous. Physicians and other medical personnel who rely on circaseptan rhythmicity in, for example, diagnostic procedures and determining the optimal dose of medications to administer should be cautious in these procedures, especially if the patient is examined or treated during the part of the year in which the boundary between the weekend and the working week is dispersed.[28]

One well-known phenomenon is related to circaseptan fluctuations of mood: the "blue Monday" phenomenon. A great number of movies, music and works of literature depict characters who complain about their extremely low mood on Mondays. It is not uncommon to hear people in everyday life reporting how they feel the worst on Mondays either. However, empirical results show no support for this phenomenon. Studies show that the mood on Mondays is not significantly lower than on the other days of the working week [13,16,25] and that the actual nadir of the mood may be closer to Tuesday.[28] An interesting finding showed that mood, measured through self-report inventories, was equally low on Monday as on the other days of the week, but the participants of the research still insisted that the Monday was their worst day of the week. There are currently no empirically tested hypotheses which could explain such disparities. One of the possible options is that the difference in mood is greatest between Sunday and Monday and that the participants are actually complaining about this sudden drop when reporting about their lowered mood on Mondays[29] (Figure 2).

CIRCANNUAL RHYTHMS OF MOOD

Whereas studies of circadian and circaseptan variations of mood typically measured mood in a population of healthy individuals, with research only later being extended to measure relations between disrupted circadian variations of mood and some psychiatric entities, studies of circannual variations of mood almost exclusively focus on depressive symptoms. It is important to distinguish between depressive mood and negative affect. Negative affect is a broader term that may also include angry, fearful and other unpleasant feelings, while depressive symptoms are mostly linked with sadness and anxiety. Seasonal affective disorder (SAD) is a well-documented mood disorder encompassed in International Statistical Classification of Diseases and Related Health Problems (ICD-10) under F33 (recurrent depressive disorder) and the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) recognizes a specifier "with seasonal pattern" for major depressive disorder (296.xx). Studies of SAD have shown that in most people suffering from this disorder, the frequency and intensity of depressive symptoms are highest in the winter.[30] To explain this finding, scientists have again turned to predictive homeostasis. The function of depressive symptoms may be opposite to the function of positive affect. While positive affect energizes the organism and stimulates it to engage in activities, depressive persons are often exhibiting symptoms of avolition and anhedonia. The potential function of lowered mood in winter months may be to reduce the activation level of organism, which in turn severely lowers the amount of calories the organism needs to intake to function. This type of an evolved mechanism would be adaptive since food is generally more difficult to obtain in winter due to unbefitting weather conditions. This hypothesis is supported by empirical tests which show that the availability of the serotonin transporter (5-HTT) in the brain shows circannual variations.[31] Some theorists view hibernation, which can be observed in some animal species, as an extreme form of such an evolved mechanism. In accordance with this hypothesis, empirical research has found that the prevalence of SAD increases as the geographical latitude is further from 0° (the equator).[32] SAD can be very rarely (if ever) found among the inhabitants of the tropical climate zone, which does not experience winter.[33] On the other hand, the prevalence of SAD is greater among the inhabitants of Scandinavian countries, Alaska and northern parts of Canada.[34]

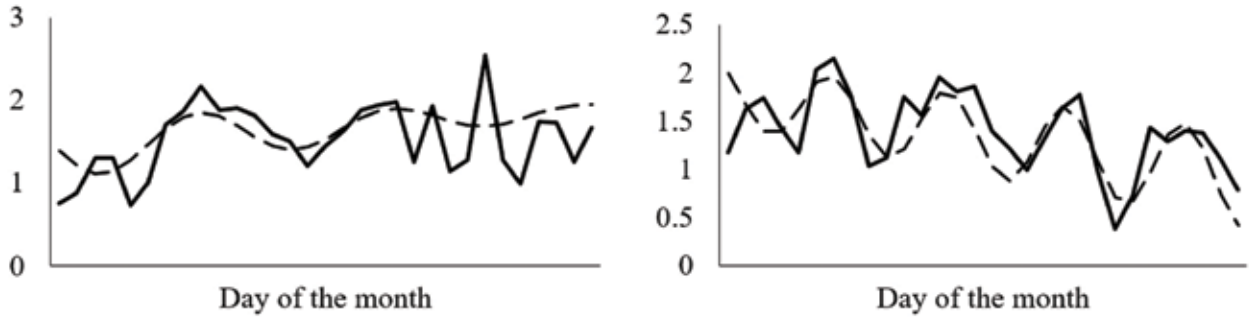

Figure 2. Fluctuations of mood show a clear circaseptan pattern in November (right panel), but not in July (left panel).
Source: Mutak A. Kako struktura tjedna utječe na naše raspoloženje?
Paper presented at the 5th Psihozij conference; May 13-15, 2017; Zagreb, Croatia.

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Theories and research still need to examine the prevalence of SAD within the Arctic and the Antarctic circle, which, like tropical climate, also deviate from "conventional" change of seasons.

However, certain individuals display an opposite seasonal pattern of depression, with most depressive symptoms occurring during summer. The causes of this pattern are still unknown, but research has found that persons suffering from "summer depression" display more agitated symptoms (e.g. irritability, "racing thoughts", motor agitation) in contrast with sufferers of "winter depression" who display signs of fatigue and lack of energy.[35] However, more studies need to be conducted to explain the phenomenon of "summer depression". More research is also needed to explore the circannual variations of mood in non-depressed individuals.

THE DISPARITY BETWEEN SUICIDE RATES AND SAD RATES

The belief that suicide rates display a clear yearly rhythm which is analogous to the yearly mood rhythm is very popular, which is not surprising since it is known that depression carries a high risk of suicide. However, empirical studies have found different results. A circannual rhythm of suicide was indeed detected; however, suicide rates reached their peak in late-spring and early-summer months. This finding was replicated in many countries.[36-39] There is currently no scientific consensus regarding the source of discrepancy between suicide rates and mood and several competing hypotheses are currently available. One hypothesis holds that depressive people ideate suicide in the winter months, but postpone the execution of the act due to societal festivities (e.g. Christmas, Easter).[40] Another hypothesis is based on the fact that depressive people are more isolated from social activities due to their lower energy levels. In agricultural societies, the general population is less active during the winter due to the fact that most crops cannot be cultivated in the winter. As the spring starts, members of the society become more active and more socially engaged, while depressive people remain inactive and are even more socially isolated. It is hypothesized that this increase in the subjective felling of "being left out" can lead to higher suicide rates. Some studies have indeed demonstrated that the spring peak of suicide rates is greater in agricultural than in industrialized countries.[41] A third hypothesis posits that hopelessness, and not depression itself, is a main predictor of suicide. Since hopelessness can be a residual symptom of depression,[42] it is possible that hopelessness increases during the remission phase of depression because the person is fearing that he/she will never "be cured" from depression, which may lead to suicide.[43] Clearly more empirical research is needed to explain the phase difference between mood and suicide rates (Figure 3).

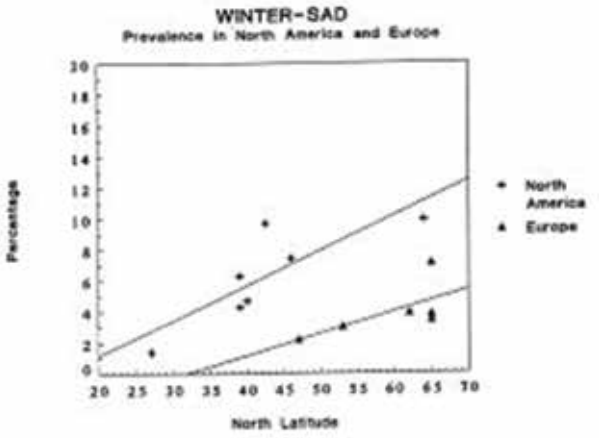

Figure 3. Plots of the prevalence rates of winter SAD in the USA and Europe in relation to latitude. The straight lines are linear curve-fits. *Source: Mersch PP, Middendorp HM, Bouhuys AL, Beersma DG, van den Hoofdakker RH. Seasonal affective disorder and latitude: a review of the literature. J Affect Disord. 1999;53(1):35-48. doi:10.1016/S0165-0327(98)00097-4. Copyright © 1999 Elsevier Science B.V. Published by Elsevier Inc. All rights reserved.*

CONCLUSION

Current research shows that positive affect varies on a circadian basis, while negative affect does not. This finding is explained through evolutionary theories which posit that the role of positive affect is to increase the activation level of the organism, which needs to be highest during the afternoon, since humans are a diurnal species, and lower in the mornings and evenings. Negative affect, on the other hand, is associated with states of fear and anger which need to be more flexible to allow for more efficient behavioral responses throughout the day. Studies on circaseptan rhythms of mood show that mood is higher on the weekends and lower during the working week. However, this effect disappears in the parts of the year when the boundaries between the working week and the weekend are less established. Thus, circaseptan rhythmicity of mood is best accounted for by cultural theories. Lastly, research on circannual rhythms of mood has mostly been focused on depressive mood and has shown that depressive symptoms are most prominent in the winter. This finding is also explained with evolutionary theories which hold that the activation level of the organism, which mood is an indicator of, needs to be lower in the winter to decrease the need for food intake in weather conditions which make obtaining food more difficult.

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RITMIČKE VARIJACIJE RASPOLOŽENJA

Sažetak

U ovom članku dan je pregled istraživanja o cirkadijurnim (dnevnim), cirkaseptalnim (tjednim) i cirkanualnim (godišnjim) varijacijama pozitivnog afekta, negativnog afekta i ukupnog raspoloženja. Istraživanja cirkadijurnih ritmova raspoloženja, koja su većinom bila usmjerena na fluktuacije pozitivnog i negativnog afekta, ukazuju kako pozitivni afekt pokazuje cirkadijurne varijacije, dok ih negativni afekt ne pokazuje. Takvi nalazi povezuju se s prediktivnom, odnosno reaktivnom homeostazom. Funkcija pozitivnog afekta mogla bi biti da potakne organizam da bude aktivniji tijekom sredine dana, dok bi funkcija negativnog afekta mogla biti odgovaranje na neposredne prijetnje koje se mogu pojaviti u bilo koje doba dana. Istraživanja o cirkaseptalnim ritmovima raspoloženja često su proučavala i ukupno raspoloženje uz pozitivni i negativni afekt. Trenutni nalazi pokazuju da je raspoloženje više tijekom vikenda nego tijekom radnog tjedna. Moguće je da su takve varijacije kulturalno određene, no potrebno je još istraživanja kako bi se došlo do stabilnog zaključka. Istraživanja cirkanualnih ritmova raspoloženja većinom su bila usmjerena na sezonski afektivni poremećaj (SAP). Stope SAP-a najviše su zimi, premda manji broj pacijenata pokazuje depresivne simptome u ljetnim mjesecima. Smatra se da je prediktivna homeostaza mehanizam koji se nalazi u podlozi SAP-a budući da SAP čini organizam manje aktivnim, čime se smanjuje količina hrane koju organizam treba konzumirati tijekom zimskih mjeseci, kada su izvori hrane oskudni. Dan je pregled razlika između godišnjih fluktuacija stopa SAP-a i stopa samoubojstava.

KLJUČNE RIJEČI: afekt, cirkadijurni satovi, cirkaseptalni, periodičnost, sezonski poremećaj raspoloženja

Received July 10, 2017.
Accepted November 29, 2017.