MAPPING OF CIRCASEPTAN AND CIRCADIAN CHANGES IN MOOD

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A b s t r a c t

Circadian changes in mood have been described earlier. A positive affect (PA) has been separated from a negative affect (NA), as independent components in opposite admittedly subjective directions, a circadian rhythm characterizing both aspects. Herein, the time structure (chronome) of human mood is re-examined and extended from the circadian to the circaseptan domain by a meta-analysis of data on 196 clinically healthy students who filled out the positive (PA) and negative (NA) affective scale (PANAS), consisting each of 10–item mood scales. Both PA and NA are found by cosinor to be characterized by a circaseptan, circasemiseptan, and circadian variation. The circaseptan and circasemiseptan amplitudes are found to be larger than the circadian amplitude for NA, whereas the circadian amplitude is largest for PA. Complementing differences in relative circaseptan-to-circadian prominence between PA and NA are differences in the timing of the circadian, circasemiseptan, and circaseptan components of PA and NA. An even broader spectrum of rhythms may include a circadecadal modulation. With this qualification, the information on the time structure of mood provides endpoints to be considered in any attempt to optimize psychological well-being by making sleeping, dietary, and/or other lifestyle adjustments.

K e y w o r d s

Circadian rhythm, Circaseptan rhythm, Human mood, Possitive and Negative affect, „PANAS“

INTRODUCTION

Circadian (*1*) and infradian (*2*) rhythms have been documented for human mood, whether self-rated, e.g., along a 7–point scale (*1*) or otherwise (*2*). It was found consistently in clinically healthy medical students (*3*) as well as in patients (*2, 4–8*). In a 30–year long record of self-measurements carried out about 5 times a day each day with only few interruptions, components other than the circadian rhythm have been detected, notably an about 11.5–year variation (*9*). In manic-depressive

Table 1
Population-mean cosinor-derived point and interval estimates in positive affect (PA), negative affect (NA) and total affect of 196 clinically healthy subjects*

Period (hours)	Variable	PR (%)	P	Amplitude (95% CI)	Acrophase (95% CI)
168	PA	11.6	0.048	0.50 (0.11, 0.90)	-267° (-219, -317)
	NA	16.8	<0.001	0.62 (0.33, 0.91)	-134° (-102, -169)
	Total	12.3	0.068	0.46 ( )	-187° ( )
84	PA	6.8	<0.001	0.80 (0.54, 1.06)	-277° (-258, -297)
	NA	8.6	<0.001	0.57 (0.34, 0.79)	-128° (-105, 155)
	Total	8.0	0.058	0.42 ( )	-235° ( )
24	PA	18.6	<0.001	3.99 (3.61, 4.37)	-249° (-244, 254)
	NA	7.2	0.031	0.35 (0.09, 0.61)	-81° (-49, -119)
	Total	15.4	<0.001	3.65 (3.23, 4.07)	-248° (-243, -253)
12	PA	5.7	<0.001	1.03 (0.80, 1.27)	-148° (-136, -161)
	NA	4.3	0.365	0.10 ( )	-229° ( )
	Total	5.6	<0.001	1.05 (0.81, 1.30)	-154° (-140, -167)

*PR: Percentage Rhythm, average proportion of variance accounted for by cosine curve with given period fitted to individual data services; P: P-value from zero-aplitude test; MESORs (±SE) of PA, NA and Total are 23.73±0.35, 16.01±0.30 and 39.73±0.47

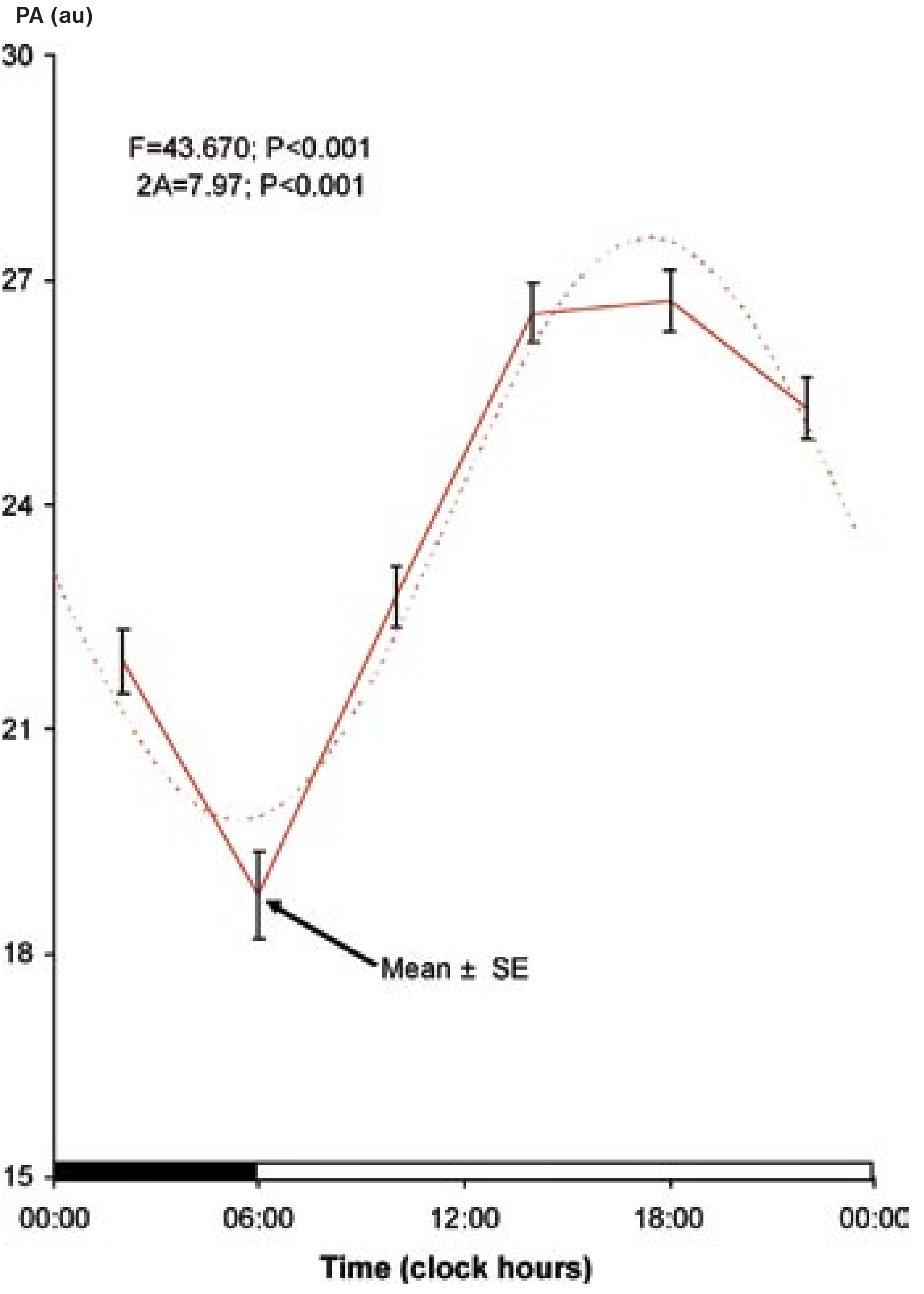

Fig. 1
Circadian rhythm in positive affect

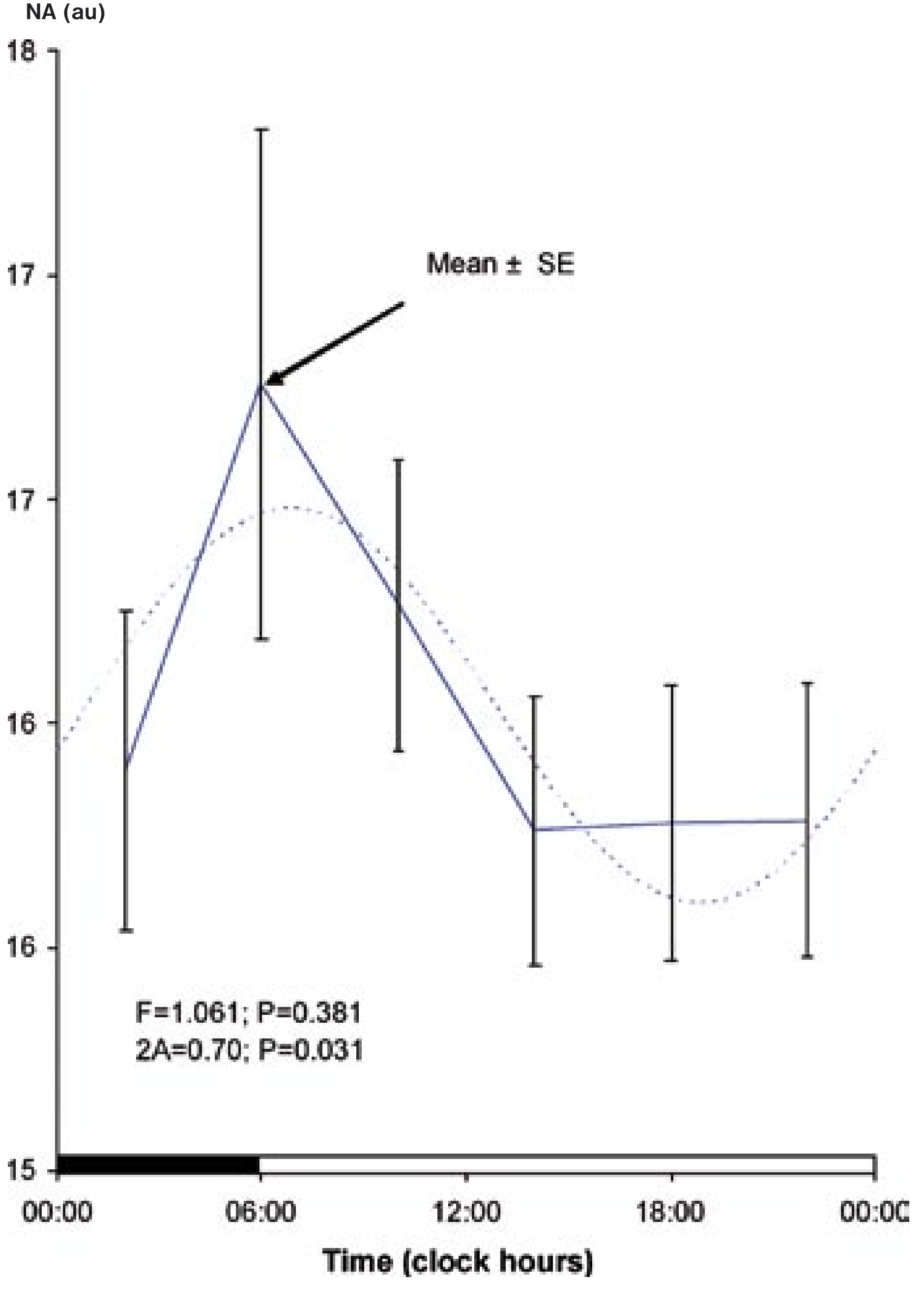

Fig. 2
Circadian rhythm in negative affect

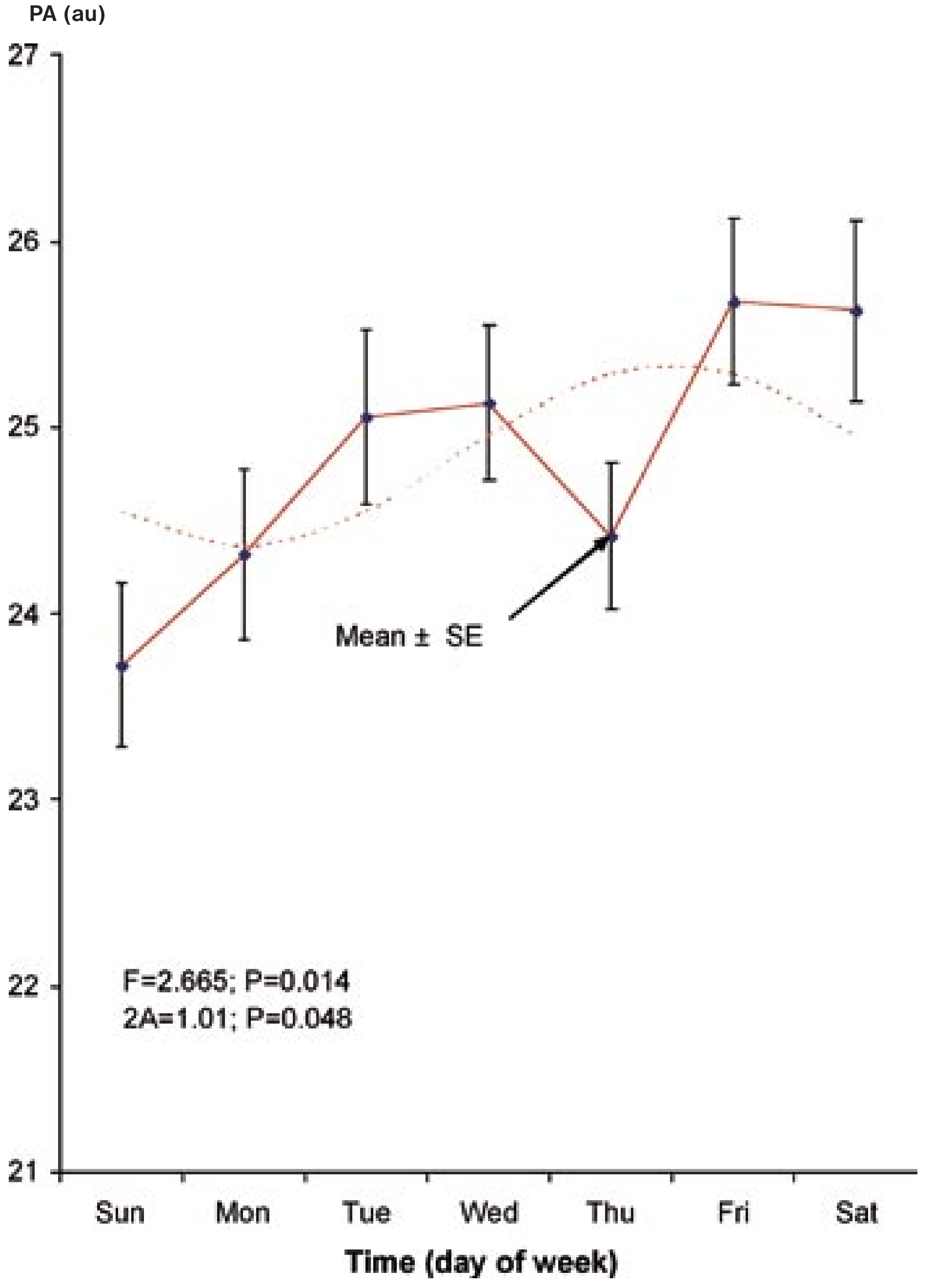

Fig. 3
Circaseptan rhythm in positive affect

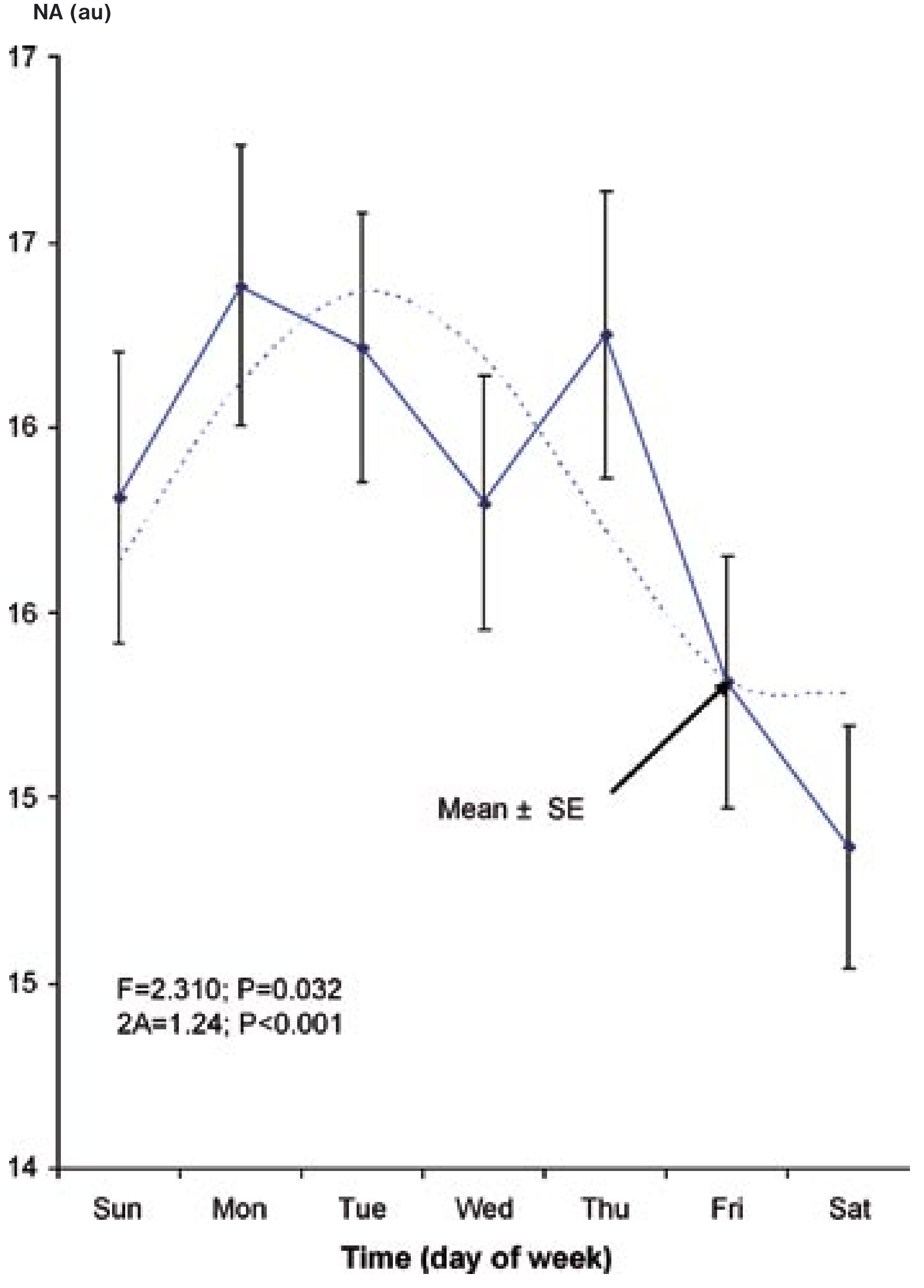

Fig. 4
Circaseptan rhythm in negative affect

disorder, a circadian rhythm in blood eosinophils may gauge a free-running adrenal cycle *(2, 10)*, and is associated with overt infradian changes in mood as extreme as the alternating bipolar states.

These earlier studies did not differentiate between the reportedly independent positive and negative affect (*11-15*). In an about 3-month record on a clinically healthy man, a circadian variation was detected for both positive and negative affect, the independence of the two mood scales also being corroborated (*16*). Herein, 7-day records at mostly 3-hour intervals from 196 clinically healthy students previously analysed for the circadian variation (*17*) are re-analysed to map any circaseptan as well as circadian variation in positive and negative affect.

MATERIALS AND METHODS

As outlined elsewhere (*17*), the subjects were 196 college students in two studies who completed a mood rating form approximately 7 times a day for 1 week. Subjects filled out forms upon rising and retiring, and at scheduled 3-hour intervals in between. The PANAS questionnaire consists of two 10-item mood scales that are reportedly highly internally consistent, largely uncorrelated, and stable (*11-15*). Each item is rated on a 5-point scale. The positive affect (PA) was calculated as the sum of the scores for the 10-item scales for positive affect, and the negative affect (NA) was calculated as the sum of the scores for the 10-item scales for negative affect. The overall mood was calculated as the sum of the PA and NA scores.

Each data series was analysed by least squares spectrum, involving the least squares fit of cosine curves with fixed periods in the frequency range of one cycle per week to two cycles per day, by cosinor (*18*, *19*). The results at a given trial period were summarized across all students by population-mean cosinor (*18, 19*). The circadian and circaseptan waveforms were further visualized by averaging the data from all students along the scales of an idealized day and week, respectively, after expressing the individual data as a percentage of the series' mean value (to remove inter-individual variation in overall mood).

RESULTS

In addition to the previous demonstration of a circadian rhythm (*17*), a circaseptan variation is also found to be statistically significant, *Table 1*. The circadian and circaseptan acrophases differ between PA and NA, as evidenced by the non-overlap of the respective 95% confidence intervals for the acrophase (*Table 1*). The 84-hour (half-week) and 12-hour (half-day) components are also detected with statistical significance (except for the 12-hour component in NA), suggesting that the circadian and circaseptan waveforms depart from sinusoidality. As seen in *Table 1*, the weekly and half-weekly amplitudes are larger than the circadian amplitude for NA, whereas in the case of PA, the circadian variation is most prominent. The patterns in relative data (expressed as a percentage of each student's average value) shown in *Figs. 1-4* clearly illustrate the differences in relative circaseptan vs. circadian prominence and in the acrophase of each component between positive and negative affect.

DISCUSSION AND CONCLUSION

The strength of the results herein stems from the relatively large population size. The greater prominence of the circaseptan as compared to the circadian variation in negative affect is in keeping with the results from a case report of a woman with bipolar disorder where the circaseptan component of overall mood was found to be amplified during a 2-week episode of depression (*20*). The results are also in keeping with those of a study of 14 healthy females showing a prominent circadian variation in positive affect but not in negative affect during a 27-hour constant routine (*21*).

The mapping of both circaseptan and circadian changes in mood may be helpful to optimize mood by making appropriate adjustments in sleeping habits, diet, and/or other lifestyle factors. For instance, vitamin D3 has been reported to enhance positive affect with some evidence of a reduction in negative affect (*22*). It has also been suggested that moderate changes in the timing of the sleep-wake cycle may have profound effects on subsequent mood (23). A study of 6 male graduate students over a 7-day span also led the authors to conclude that adrenaline accumulation correlated with physical fatigue, whereas cortisol was associated with alertness and ratios of adrenaline, noradrenaline, and dopamine were related to tenseness and irritability (*24*). Less daily illumination was also reportedly associated with poorer global functioning, longer but more disturbed sleep, and more depression (*25*).

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MAPOVÁNÍ CIRKADIÁNNÍCH A CIRKASEPTÁNNÍCH ZMĚN V NÁLADĚ

Souhrn

Cirkadiánní změny v náladě byly již dříve popsány. Pozitivní afekt (PA) byl oddělen od negativního afektu (NA) a tyto nezávislé komponenty v protikladných subjektivně určených směrech charakterizuje cirkadiánní rytmus v obou případech. Časová struktura (chronom) nálady člověka je znovu vyšetřena a prodloužena z cirkadiánní do cirkaseptánní (přibližně týdenní) domény metaanalýzou dat 196 klinicky zdravých studentů, kteří vyplnili dotazník Pozitivní a negativní afektivní stupnice (PANAS), skládající se z 10 náladových stupňů. V obou PA a NA byly pomocí kosinorové analýzy nalezeny cirkaseptánní, cirkasemiseptánní (asi půltýdenní) a cirkadiánní rytmy. Cirkaseptánní a cirkasemiseptánní amplitudy byly větší než cirkadiánní amplituda v NA, zatímco cirkadiánní amplituda byla největší v PA. Další rozdíly, vedle rozdílů v poměru cirkaseptánní-cirkadiánní amplitudy, jsou rozdíly v časování cirkadiánních, cirkasemiseptánních a cirkaseptánních komponent v PA a NA. Širší spektrum rytmů může zahrnovat cirkadekadální (asi desítiletou) modulaci. S tímto poznáním, infor-

mace o časové struktuře nálady poskytuje výstupy, které by měly být brány v úvahu při každé snaze optimalizovat psychologický komfort pomocí úprav doby spánku, dietních úprav a/nebo dalších modifikací životního stylu.

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