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Relationships between eveningness, bedtime procrastination, morning functioning, and skipping breakfast

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ABSTRACT

Inter-relationships among eveningness, bedtime procrastination (BP), morning affect (MA), and breakfast skipping were investigated in 219 adults (aged 18–89, mean age = 26.2 years). Consistent with previous research, greater eveningness preference was associated with more BP, more breakfast skipping, and lower MA (i.e. less alert at awakening/requiring longer to fully awake). Two mediation models were tested: BP as a mediator between eveningness and MA, and MA as a mediator between eveningness and breakfast skipping. Results supported the first model, as more eveningness had an indirect effect through more BP to lower MA. The reversed model (BP mediating between MA as the predictor for eveningness) was also significant, indicating a bidirectional relationship. In contrast, MA did not mediate the relationship between eveningness and breakfast skipping, suggesting a more direct influence of time of day preference on eating behaviour. The reversed model (MA mediating between breakfast skipping as the predictor for eveningness) showed significance, but not after including covariates. These findings underscore the role of bedtime procrastination in undermining morning functioning, highlight a direct link between time of day preference and breakfast consumption, and suggest a bidirectional relationship between eveningness and MA. Longitudinal research may clarify causality and explore additional mediators.

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KEYWORDS
Morningness-eveningness; morning affect; bedtime procrastination; breakfast skipping

Introduction

Sleep patterns are influenced by chronotype, the individual expression of the endogenous circadian rhythm that sets earlier or later sleep schedules, which closely relate to individual morningness-eveningness preferences for sleep/wake and activity times (Adan et al. 2012; Randler et al. 2016). Morning-types prefer early rising and activity engagement, while evening-types prefer rising later and tend to be more alert during evening hours; most people are intermediate between these extremes (Adan et al. 2012).

Morningness-eveningness is a strong predictor of health outcomes with morning-oriented individuals generally engaging in healthier behaviours such as lower likelihoods of smoking and alcohol consumption, as well as higher levels of physical

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activity, while evening-oriented individuals are more likely to exhibit these risk behaviours (Urbán et al. 2011; Suh et al. 2017). Evening preference is also associated with increased levels of depression, anxiety, and stress, and with a higher risk of all-cause mortality (Knutson and von Schantz 2018), whereas morningness is linked to improved mood and well-being (Seizer et al. 2024). Academic performance has also been linked to chronotype, as evening-types often struggle to align with conventional schedules for early school start times which can negatively impact their performance (Imam et al. 2024), and in occupational settings evening-types often experience reduced work ability and job performance, particularly in daytime schedules (Kiema-Junes et al. 2024). These effects may be due to social jetlag (SJL), in which an individual's social schedule is misaligned with their biological clock, resulting in forced wake times which do not match their circadian rhythm (Wittmann et al. 2006; Taillard et al. 2021).

The later circadian rhythm also predisposes evening-types to engage in more evening activities, including more online and in-person social interaction (Jankowski et al. 2014; Aledavood et al. 2018). This may lead to further delaying sleep. Evening preference correlates with high general procrastination (Digdon and Howell 2008), and also correlates specifically with bedtime procrastination (BP), particularly among adolescents who naturally experience a shift toward later sleep schedules (Kadzikowska-Wrzosek 2018; Kühnel et al. 2018; Pu et al. 2022). BP has been associated with insufficient and poor quality sleep and daytime fatigue (Kroese et al. 2014; Kadzikowska-Wrzosek 2018; Pu et al. 2022; Zhu et al. 2023), and these associations remain after controlling for chronotype (Carlson et al. 2023). BP also has been linked with experiencing more day-time stress (Schmidt et al. 2024), and a growing body of research into digital media use presents a mechanism for delayed bedtime, with evening-types engaging in excessive screen consumption at night, reinforcing BP (Exelmans and Van den Bulck 2017; Shimura et al. 2018). This may be related to wanting more time for self-chosen activities ("revenge bedtime procrastination") as sleep is delayed in order to reclaim personal time lost to daily responsibilities (Kroese et al. 2014; Hill et al. 2024). Low self-regulation also plays a key role in BP, as individuals with poor impulse control struggle to resist distractions, thus failing to adhere to planned bedtimes (Kadzikowska-Wrzosek 2018); consistent with this, eveningness is associated with lower self-control (Digdon and Howell 2008; Carciofo and Cheung 2025).

The tendency towards BP in evening-types may contribute to social jetlag and exacerbate associated sleep deprivation, which negatively impacts cognitive functioning and emotional regulation (Pilcher and Huffcutt 1996; Ellenbogen 2005). In addition, individuals may experience lower morning affect (MA), i.e. less alertness and energy at awakening (Randler et al. 2016). MA is conceptually related to sleep inertia, the paradoxical feeling of tiredness immediately after waking, with associated negative effects on cognitive functioning (Trotti 2017; Carciofo 2023). Sleep inertia is associated with shorter sleep duration and with depression (Kanady and Harvey 2015), and is more likely when rising at a time closer to the nadir of the core body temperature rhythm (Scheer et al. 2008), as may occur when evening-types experience social jetlag. Consistently, eveningness is associated with lower MA/more sleep inertia (Roenneberg et al. 2003; Ma et al. 2022; Carciofo 2023, 2024). Thus, the possibility is suggested that bedtime procrastination may act as a mediator between more eveningness and lower MA.

As evening-types are more likely to procrastinate bedtime and to experience social jetlag, this may also impact the likelihood of consuming breakfast. Breakfast skipping has been linked to a range of adverse health effects, including metabolic disturbances, cognitive deficits, and also impaired academic performance, particularly among adolescents and young adults (Mazri et al. 2019); it is also associated with higher rates of depressive symptoms and poorer sleep (Al Balushi and Carciofo 2023; Xian et al. 2023). Skipping breakfast and having an evening chronotype have also been associated with impaired glycaemic control in patients with type-2 diabetes, even after accounting for diabetic complications (Reutrakul et al. 2014). Evening-types often exhibit distinct dietary patterns, characterized by a higher overall caloric intake, greater consumption of energy-dense foods, and a preference for nighttime eating, likely due to increased alertness during later hours (Toktaş et al. 2018). Furthermore, evening-oriented individuals are more likely to forgo breakfast (Meule et al. 2012; Teixeira et al. 2018; Al Balushi and Carciofo 2023; Xian et al. 2023); Toktaş et al. (2018) report that 60% of evening chronotypes skip breakfast, though a scoping review by Mazri et al. (2019) suggests a lower estimate of 38%.

Furthermore, skipping breakfast has been associated with lower Morning Affect (Al Balushi and Carciofo 2023), indicating coherent inter-relationships between more eveningness, bedtime procrastination, and experiencing lower alertness, mood, and motivation in the morning, which may negatively impact the likelihood of adhering to healthy structured morning routines, including the consumption of breakfast. Morning affect appears to be an important factor in mental health (Konttinen et al. 2014; Jankowski 2016; Díaz-Morales et al. 2017), and may provide a mechanism for associations between eveningness and wellbeing. Lower MA has been found to mediate between eveningness and negative emotionality (Carciofo 2020). So, given the inter-relationships between more eveningness, lower MA upon awakening, and the increased likelihood of breakfast skipping, MA may provide a mechanism for the association between eveningness and skipping breakfast.

Thus, the current study aimed to further investigate the inter-relationships between eveningness, BP, MA, and breakfast skipping, and potential mediating mechanisms that may underpin these relationships, particularly regarding the role of BP and MA as mediating variables. While causality cannot be determined due to the cross-sectional design, mediation analysis allows for the exploration of potential mechanisms. Based on existing literature, positive associations between eveningness, BP, and breakfast skipping were hypothesised, while expecting negative associations with MA. Furthermore, it was hypothesised that BP mediates the relationship between eveningness and MA, and that MA mediates the relationship between eveningness and breakfast skipping. In addition, recent research has highlighted Distinctness, i.e. amplitude of diurnal variations in cognitive functioning and mood (Ogińska 2011; Randler et al. 2016) as an important component of circadian functioning, so associations with this component were also explored. Given that more Distinctness has been associated with indices of poorer wellbeing and with lower MA (Díaz-Morales et al. 2017; Carciofo 2020), positive associations with BP and breakfast skipping may be expected.

Methods

Participants

The only inclusion criterion for recruitment of participants was being aged 18 years and older. Self-selected participants responded to study adverts placed on (1) the University of Reading psychology research participation platform (SONA), where participants were recruited for course credits; (2) Prolific (https://www.prolific.com/), where remunerated participants were recruited, and (3) social media platforms, where participants were recruited without compensation. Data was collected between November 2024 and February 2025. Following Cohen's (1992) recommendations, correlation coefficients of 0.1, 0.3, and 0.5 may respectively indicate small, medium, and large effect sizes, and $N = 194$ is adequate to establish small-medium correlations of 0.2 with 80% power at the 0.05 significance level (https://homepage.univie.ac.at/robin.ristl/samplesize.php?test=correlation). This target sample size was set following similar correlational studies (e.g. Carciofo 2022; Al Balushi and Carciofo 2023). Of the 240 participants who began the survey, complete data was provided by 219 participants (157 SONA, 24 Prolific, 38 social media). The age range was 18–89, mean age = 26.22 years old, $SD = 14.079$ (median = 20 years old, skewness = 2.310); 158 (72.1%) identified as female ($M = 25.12$ years old, $SD = 12.877$), 54 (24.7%) as male ($M = 30.28$ years old, $SD = 17.265$), and 7 (3.2%) as other ($M = 19.71$ years old, $SD = .756$); the male-female age difference was significant $t = 2.012$ (df = 74.162; Glass' delta = .401), $p = .048$. Self-identified ethnicity was: White = 67.1%; Asian or Asian British = 20.5%; Black, Black British, Caribbean or African = 2.7%; Mixed = 6.4%; Other = 3.2%.

Participation was voluntary and could be withdrawn at any time. Informed consent was obtained following a briefing, and a debriefing was provided upon completion of the study. The research protocol was approved by the Research Ethics Committee of the School of Psychology and Clinical Language Sciences, University of Reading (2024–151-RC).

Materials

The online survey was hosted on the REDCap platform (Harris et al. 2019).

The Bedtime Procrastination scale (Kroese et al. 2014) consists of 9 items rated on a 5-point, Likert-type scale. The validity and reliability of the scale has been cross-culturally tested (Herzog-Krzywoszanska and Krzywoszanski 2019; Hazumi et al. 2024), and has shown consistent results. The scale includes items such as *"I easily get distracted by things when I actually would like to go to bed"*, which were scored from 1-almost never, to 5-almost always. Items 2, 3, 7, and 9 are reverse-scored, and a higher total score indicates more frequent and severe bedtime procrastination.

The Morningness-Eveningness-Stability-Scale-improved (MESSi; Randler et al. 2016) has five items assessing each of: evening preference (EV; e.g. *"I feel I can think the best in the evening"*), Morning Affect (MA, e.g. *"I feel drowsy for a long time after awakening"*), and Distinctness (DI, e.g. "*There are moments during the day where I feel unable to do anything*"). Items are rated on 5-point scales; items 6, 8, 9, and 10 were reverse-scored. Higher total scores for EV/MA/DI, respectively, represent a stronger evening orientation, more MA (easier/quicker transition from sleep to awake), and more DI (stronger diurnal variations in functioning). The scale has shown good validity and reliability (Randler et al. 2016; Carciofo 2024).

Skipping breakfast was tested by responses to *"How often did you skip breakfast in the past week?"*, with the options being *1 = never; 2 = one or two days; 3 = three or four days; 4 = five or six days; 5 = every day*. A higher score indicates a higher frequency of breakfast skipping. Single-item measures of meal frequency have been commonly used and shown consistent results (e.g. Al Balushi and Carciofo (2023); Xian et al. (2023).

The Single-Item Sleep Quality Scale (SQS; Snyder et al. 2018) provides a measure of overall subjective sleep quality for the previous 7 days, rated from 0 (Terrible) to 10 (Excellent). The measure has shown concurrent validity and test–retest reliability.

Demographic items included age, gender (male, female, other), ethnicity, and questions for history of diagnoses of depression and history of eating disorder (yes/no). Scales assessing additional variables were also included in the survey as part of a separate research project.

Data analysis

Descriptive statistics included skewness, kurtosis, the mean, standard deviation, and internal consistency (Cronbach's alpha). Normality of distributions was checked with the Kolmogorov–Smirnov test and visual inspection of histograms. To examine the relationships between eveningness, MA, BP, and breakfast skipping bivariate Pearson correlations were conducted; partial correlations controlled for demographic factors. Point-biserial correlations are reported between study variables and binary variables (male/female, and yes/no for history of mental disorder). Finally, mediation analyses were conducted using the PROCESS macro for SPSS (Hayes 2018a, 2018b) to explore potential indirect effects: (1) BP mediating the relationship between eveningness and MA, and (2) MA mediating the relationship between eveningness and breakfast skipping. The reversed models was also tested. For ease of interpretation standardised regression coefficients are reported, along with 95% percentile confidence intervals (CI) derived from 5000 bootstrapped resamples for which significance is indicated by the exclusion of zero (Preacher and Hayes 2004); r^2 values for mediation effects are also reported (Fairchild et al. 2009). When path a (predictor to mediator) and path b (mediator to outcome, controlling for the predictor) each have a small to medium value of 0.26, a minimum sample of $N = 162$ is required to achieve 80% power when using the percentile bootstrap method for calculating the indirect effect; if both path a and path b are small (0.14), then $N = 558$; if either path a or path b is small (0.14), and the other is at least small-medium (0.26) then approximately $N = 414$ (Fritz and MacKinnon 2007).

Results

Descriptive statistics

Results of Kolmogorov–Smirnov tests were significant for all measures, indicating deviation from normality. However, absolute values of skewness were mostly small (all <1), as were those for kurtosis (mostly <1), and visual inspection of histograms indicated approximate normality of the distributions. Internal consistency was good, with all values of Cronbach's alpha being > .7. See Table 1.

Table 1. Descriptive statistics.

	Mean (SD)	Minimum-maximum (possible)	Skewness	Kurtosis	Cronbach α
Morning Affect	14.50 (4.777)	5–25 (5–25)	0.16	−0.76	0.88
Eveningness	16.71 (4.661)	5–25 (5–25)	−0.18	−0.71	0.85
Distinctness	18.18 (3.777)	7–25 (5–25)	−0.71	0.31	0.75
Bedtime Procrastination	31.68 (7.999)	9–45 (9–45)	−0.67	−0.31	0.91
Sleep Quality	5.46 (2.199)	0–10 (0–10)	−0.30	−0.44	–
Breakfast Skipping	2.75 (1.370)	1–5 (1–5)	0.32	−1.08	–

N = 219

History of diagnosis of depression was reported by 21.5% of participants, and history of eating disorder was reported by 7.8% of participants. Depression diagnosis (0 = no, 1 = yes) significantly correlated with MA, $r = -.179$, $p = .008$, but there were no other significant correlations between diagnosis status (depression or eating disorder) and MA, EV, DI, BP, sleep quality, or breakfast skipping. Age significantly correlated with all study variables: MA, $r = .408$; EV, $r = -.249$; DI, $r = -.497$; BP, $r = -.395$; breakfast skipping, $r = -.201$; sleep quality, $r = .243$ (all $ps < .01$). There were no male-female differences for the study variables, except for DI: male mean = 16.76 ($SD = 4.107$), female mean = 18.62 ($SD = 3.572$), $t = -3.179$ (df = 210; Hedges $g = -.499$), $p = .002$.

Correlations

The expected directional associations emerged: EV, BP, and breakfast skipping were positively correlated, while MA, and better sleep quality, showed negative correlations with these variables (all $ps < .05$), with coefficients ranging from medium to strong (Table 2). Distinctness also had significant positive correlations with breakfast skipping (small) and bedtime procrastination (medium-strong). Partial correlations controlling for age and previous diagnoses of depression and eating disorders showed mostly small changes to the observed coefficients. These findings suggest that the relationships among the primary variables remain robust even when accounting for key demographic and psychological covariates. However, the correlations with Distinctness showed more attenuation, with the Distinctness-eveningness and Distinctness-breakfast skipping correlations no longer showing significance (Table 2). We note that alternative zero-order correlation analysis utilising Spearman's rho showed near identical results, with the largest absolute difference in coefficients being 0.06, and with no changes in statistical significance at $p < .05$.

Table 2. Correlation matrix.

	Morning affect	Eveningness	Distinctness	Breakfast skipping	Bedtime procrastination	Sleep quality
Morning Affect	–	−.448***	−.314***	−.200**	−.501***	.395***
Eveningness	−.505***	–	.054	.306***	.447***	−.185**
Distinctness	−.464***	.179**	–	.051	.255***	−.262***
Breakfast skipping	−.270***	.345***	.150*	–	.247***	−.346***
Bedtime Procrastination	−.577***	.496***	.400***	.303***	–	−.507***
Sleep Quality	.448***	−.237***	−.344***	−.379***	−.548***	–

*N = 219. Zero-order correlations below the diagonal, partial correlations, controlling for age and previous diagnoses of depression and eating disorders, shown above the diagonal. *p ≤ .05; **p ≤ .01; ***p ≤ .001.*

Mediation analysis

The first hypothesised model tested whether EV had an indirect effect on MA through BP. The overall regression model was statistically significant, explaining about 40% of the variance in MA, $R = .630$, $R^2 = .397$ (adjusted = .391), $F(2, 216) = 70.968$, $p < .001$. Eveningness significantly predicted greater BP (path a), which in turn significantly predicted lower MA (path b). The total effect of eveningness on MA was significant (path c; $r^2 = 0.25$), and although the direct effect when controlling for BP was weaker, it remained significant (path c'; $r^2 = 0.09$), indicating partial mediation. The indirect (mediation) effect was statistically significant, −.2144 (95% CI = −.3003/-.1412), with $r^2 = .19$ (Figure 1). This indirect effect remained significant after including age, sleep quality, and self-reported diagnoses of depression and eating disorders as covariates ($N = 219$), and after also including gender (male/female) as an additional covariate ($N = 212$).

The reversed model was also tested: BP as the mediator with MA as the predictor for eveningness. The overall regression model was statistically significant, explaining about 32% of the variance in eveningness, $R = .564$, $R^2 = .318$ (adjusted = .312), $F(2, 216) = 50.323$, $p < .001$. All paths were significant ($ps < .05$); for the total effect of MA on eveningness, $\beta = -.505$, $p < .001$, $r^2 = 0.25$, and for the direct effect of MA on eveningness (controlling for BP), $\beta = -.329$, $p < .001$, $r^2 = 0.108$. There was a significant indirect effect, −.1764 (95% CI = −.2752/-.0874), showing partial mediation, with $r^2 = .18$. The indirect effect remained significant after including age, sleep quality, and self-reported diagnoses of depression and eating disorders as covariates ($N = 219$), and after also including gender (male/female) as an additional covariate ($N = 212$).

The second hypothesised model examined whether MA mediates the relationship between eveningness and skipping breakfast. The overall regression model was statistically significant, explaining 13% of the variance in breakfast skipping, $R = .363$, $R^2 = .132$ (adjusted = .124), $F(2, 216) = 16.369$, $p < .001$. As seen in the previous model, eveningness significantly predicted lower MA (path a). However, MA did not significantly predict breakfast skipping (path b) when controlling for eveningness ($\beta = -.1283$, $p = .08$), and while the total effect of eveningness on breakfast skipping was significant (path c; $r^2 =$

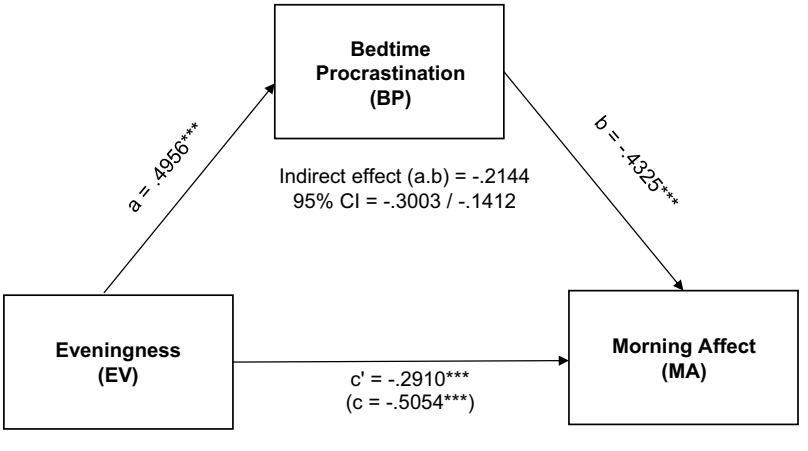

Figure 1. Mediation model depicting the effect of eveningness on morning affect via bedtime procrastination. Note: Values represent standardized regression coefficients. ***p ≤ 0.001.

0.119), the indirect effect via MA was non-significant, .0648 (95% CI = –.0081/.1453), indicating a lack of mediation, with $r^2 = 0.06$. The direct effect of eveningness on breakfast skipping remained significant (path c'; $r^2 = 0.079$), suggesting that the relationship is not explained by changes in morning affect (Figure 2). The non-significant indirect effect remained when including age, sleep quality, and self-reported diagnoses of depression and eating disorders as covariates ($N = 219$), and also when including gender (male/female) as an additional covariate ($N = 212$). As the coefficient of path b was small, a sample of >400 would be required to have 80% power to detect the indirect effect (Fritz and MacKinnon 2007).

The reversed model was also tested: MA as the mediator with skipping breakfast as the predictor for eveningness. The overall regression model was statistically significant, explaining about 30% of the variance in eveningness, $R = .550$, $R^2 = .303$ (adjusted = .296), $F(2, 216) = 46.843$, $p < .001$. All paths were significant ($ps < .05$); for the total effect of skipping breakfast on eveningness, $\beta = .345$, $p < .001$, $r^2 = 0.119$, and for the direct effect of skipping breakfast on eveningness (controlling for MA), $\beta = .225$, $p < .001$, $r^2 = 0.05$. There was a significant indirect effect, .1201 (95% CI = .0636/.1823), showing partial mediation, with $r^2 = 0.07$. However, the indirect effect was no longer significant (.0302; 95% CI = –.0247/.0861) after including age, sleep quality, and self-reported diagnoses of depression and eating disorders as covariates ($N = 219$), and not significant (.0332; 95% CI = –.0203/.0887) when also including gender (male/female) as an additional covariate ($N = 212$).

Discussion

Research has investigated associations between morningness-eveningness and eating patterns, but there has been a lack of focus on other components of circadian functioning, including Morning Affect (MA; sleep inertia/time to fully awaken) and Distinctness (amplitude of diurnal variations in functioning). The current study addressed this by investigating the inter-relationships between eveningness, BP, MA, Distinctness, bedtime procrastination (BP), and breakfast skipping, and potential mediating mechanisms that

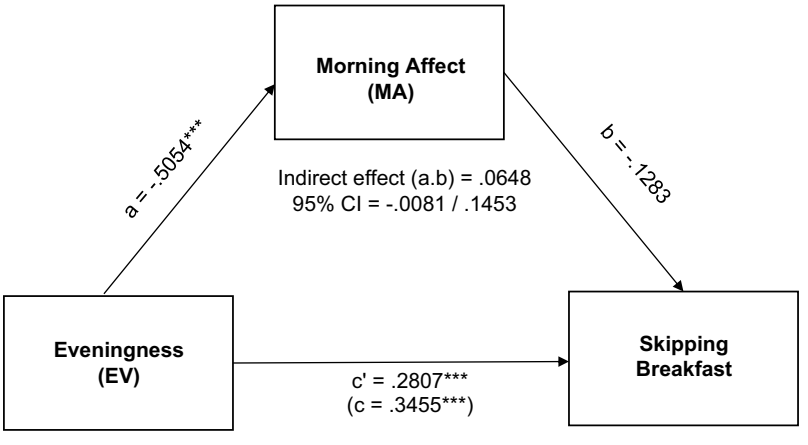

Figure 2. Mediation model depicting the effect of eveningness on skipping breakfast via morning affect. Note: Values represent standardized regression coefficients. ***p ≤ 0.001.

may underpin these relationships, particularly regarding the roles of BP and MA as mediating variables. Aligning with our hypotheses, and consistent with previous research, correlation analyses demonstrated that more eveningness was positively associated with BP (Kadzikowska-Wrzosek 2018; Kühnel et al. 2018; Pu et al. 2022) and breakfast skipping (Teixeira et al. 2018; Toktaş et al. 2018; Mazri et al. 2019; Al Balushi and Carciofo 2023), and negatively associated with MA (Randler et al. 2016; Carciofo 2023, 2024); also, bedtime procrastination was associated with low MA, as was breakfast skipping (Al Balushi and Carciofo 2023). Furthermore, Distinctness (greater amplitude of diurnal variations in functioning) positively correlated with bedtime procrastination and with breakfast skipping. While this is consistent with other evidence showing associations between Distinctness and indices of poorer wellbeing (Díaz-Morales et al. 2017; Carciofo 2020), the factors influencing variations in Distinctness, and the mechanisms underlying the associations with wellbeing, await further research.

The first hypothesised mediation model was supported: BP partially mediated the impact of more eveningness on MA, suggesting that EV influences BP, which in turn influences MA, so extending the literature by identifying BP as a behavioural mechanism through which later time of day preference undermines morning alertness. Eveningness is associated with low self-control, and these are both associated with bedtime procrastination (Digdon and Howell 2008; Kadzikowska-Wrzosek 2018; Carciofo and Cheung 2025), such as through more electronic screen time at night (Exelmans and Van den Bulck 2017; Shimura et al. 2018). BP is associated with sleep impairments, including insufficient and poor quality sleep, and daytime fatigue (Kroese et al. 2014; Kadzikowska-Wrzosek 2018; Pu et al. 2022; Carlson et al. 2023; Zhu et al. 2023). So, the observed mediating role of BP between eveningness and low morning affect (more sleep inertia) is consistent with the extant research evidence.

However, testing the reversed model (BP as a mediator between MA as the predictor and eveningness as the outcome) also produced a significant indirect effect (partial mediation), indicating a possible bidirectional relationship between eveningness and MA, with BP mediating in both cases. So, while being more evening-type may predispose to more BP (and related activities, such as use of electronic devices), which may lead to sleep disturbances and/or social jetlag which may impact MA (more sleep inertia), it may also be that experiencing more sleep inertia increases the likelihood of bedtime procrastination, which may contribute to a phase shift, increasing eveningness. A possible mechanism for this may be increased use of stimulants to combat sleep inertia and daytime sleepiness, which may prolong arousal later into the evening and hence promote bedtime procrastination such as through use of electronic devices, socialising, etc. Eveningness is associated with more use of substances such as alcohol and nicotine, as is social jetlag (Wittmann et al. 2006; Beauvalet et al. 2017; Suh et al. 2017), and smoking may be a response to the effects of SJL (Ghotbi et al. 2023). In addition, late night exposure to light from electronic devices may contribute to a phase delay, leading to more eveningness (Krejci et al. 2011).

Given the associations between eveningness, lower MA, and more likelihood of breakfast skipping, the second hypothesised mediation model tested MA as a mediator between eveningness and skipping breakfast. However, while more eveningness significantly predicted lower MA, and directly predicted breakfast skipping, MA did not significantly predict breakfast skipping when controlling for eveningness, and did not

mediate between eveningness and breakfast skipping. So, these results imply a more direct impact of eveningness on meal timing, aligning with studies reporting that breakfast skipping in later chronotypes arises from misaligned sleep-wake schedules and habitual late-night eating rather than morning lethargy (Reutrakul et al. 2014; Teixeira et al. 2018). However, it is acknowledged that this null result may be due to the relative lack of statistical power, so re-testing the model with a larger sample would allow for drawing firmer conclusions. The reversed model with MA as a mediator between breakfast skipping and eveningness did show a significant indirect effect (partial mediation). This may imply that skipping breakfast may prolong sleep inertia, which may then contribute to a phase delay/more eveningness through the same mechanisms as suggested for the reversal of the first hypothesised mediation model: more use of stimulants leading to more bedtime procrastination activities such as use of electronic devices, etc. However, this model was no longer significant after including covariates, so there may be additional mediating and/or moderating factors involved.

The limitations of the present study must be acknowledged. The cross-sectional design precludes causal inference as temporal precedence cannot be established (Spector 2019). Future research should consider longitudinal or experimental approaches to better establish the causal directionality of these relationships. The predominantly undergraduate sample limits generalizability to older or working populations whose chronotype distributions and lifestyle demands differ (Karan et al. 2021). Furthermore, a larger, more varied sample could investigate differences across age group, gender, and ethnicity. In addition, the current study did not collect data about shiftwork, recent transmeridian flight, health status, etc, which may be influential, and data about sleep timing and social jetlag were not collected. Also, reliance on self-report measures introduces potential biases such as social desirability and recall errors, and only a single-item measure of breakfast skipping with limited response options was used, which limits the interpretation of the current results. A dedicated, multi-item scale to measure breakfast skipping would be a useful development, with assessment also including, for example, the timing of the last meal before sleeping and time between waking and the first meal of the day.

While acknowledging these limitations, the validity of the current results is supported by their consistency with previous research, and the current findings have practical implications which may be further investigated. The partial mediation by BP highlights the potential importance of self-regulatory interventions for improving morning affect/alertness (reducing sleep inertia) among evening-types, which may be investigated in further research. Techniques such as implementation intentions and stimulus control may reduce bedtime procrastination and enhance morning mood (Kroese et al. 2016; Exelmans and Van den Bulck 2017). University counselling services and sleep-hygiene programmes could integrate modules targeting procrastination at bedtime. Furthermore, the persistence of a direct eveningness – breakfast skipping link suggests that interventions targeting morning affect alone may not suffice to alter breakfast habits in individuals with later sleep preferences, and that dietary interventions should focus on circadian-aligned meal planning, such as providing flexible breakfast times or encouraging small morning snacks. Sleep deprivation, sleep inertia, and breakfast skipping all negatively impact cognitive functioning and emotional regulation (Pilcher and Huffcutt 1996; Ellenbogen 2005; Kanady and Harvey 2015; Trotti 2017; Mazri et al. 2019; Al Balushi

and Carciofo 2023), so schools/universities may consider delaying start times to accommodate students with delayed sleep–wake preferences. Benefits to academic measures have been associated with such delays (James et al. 2023), and further research may investigate the extent to which more likelihood of breakfast consumption may be an influence.

Further research might also examine additional potential mediators (e.g. sleep duration, social jetlag, substance use, use of electronic devices, etc.) and moderators (e.g. conscientiousness) to map comprehensive behavioural pathways (Pilcher and Huffcutt 1996; Digdon and Howell 2008). Expanding samples to older adults, shift workers, and clinical populations (e.g. individuals with type-2 diabetes) would test the generalizability and clinical significance of these mechanisms (Reutrakul et al. 2014).

In conclusion, this study identified possible behavioural pathways in the interrelationships between eveningness, bedtime procrastination, morning affect, and breakfast skipping. Bedtime procrastination partially mediates the detrimental effect of more eveningness on morning affect, whereas breakfast skipping appears to be driven directly by time of day preference rather than immediate morning affective state. Furthermore, there may be a complex bidirectional relationship between eveningness and Morning Affect. These insights advance our understanding of the complex interplay between biological rhythms and daily health behaviours and point to targeted strategies – such as reducing bedtime procrastination and aligning meal timing – to enhance well-being and performance. Future longitudinal research is needed to establish causality and refine interventions tailored to individual chronotype profiles.

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Data availability statement

The data for this study is available at: https://doi.org/10.17864/1947.001451.

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