Insomnia Mediates the Association between Eveningness and Suicidal Ideation, Defeat,
Entrapment, and Psychological Distress in Young Adults

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The authors have no competing interests to declare.

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Abstract

Chronotype describes a person's general preference for mornings, evenings or neither. It is typically conceptualized as a continuous unidimensional spectrum from *morningness* to *eveningness*. Eveningness is associated with poorer outcomes across a myriad of physical and mental health outcomes. This preference for later sleep and wake times is associated with increased risk of depression, anxiety, and suicidal ideation and behaviors in both clinical and community samples. However, the mechanisms underlying the negative consequences of this preference for evenings is not fully understood. Previous research has found that sleep disturbances may act as a mediator of this relationship. The present study aimed to explore the associations between chronotype and affective outcomes in a community sample of young adults. Additionally, it aimed to investigate the potential role of insomnia as a mediator within these relationships. Participants ($n = 260$) completed an anonymous self-report survey of validated measures online which assessed chronotype, insomnia symptoms, and a range of affective outcomes (defeat, entrapment, stress, suicide risk, and depressive and anxious symptomology). Eveningness was associated with more severe or frequent experiences of these outcomes, with young adults demonstrating a preference for eveningness more likely to report poorer affective functioning and increased psychological distress. Mediation analysis found the relationship between chronotype and these outcome measures were partially mediated by sleep disturbances as measured by the well-validated Sleep Condition Indicator insomnia scale. Taken together, these findings add further evidence for the negative consequences of increased eveningness. Additionally, our results show that chronotype and sleep disturbances should be considered when assessing mental well-being. Implementing appropriate sleep-related behavior change or schedule alterations can offer a tool for mitigation or prevention psychological distress in young adults who report a preference for later sleep and wake times.

Keywords: insomnia, suicide, young adults, chronotype, stress, depression, anxiety

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Chronotype describes a person's general preference for mornings (M-types), evenings (E-types) or neither (N-types). It is typically conceptualized as a continuous unidimensional spectrum from *morningness* to *eveningness* with a broadly normal distribution (Gaspar-Barba et al., 2009; Roenneberg et al., 2004; Roenneberg, Wirz-Justice, & Mellow, 2003).

Chronotype is a product of both genetics and environment (Facer-Childs, Middleton, Skene, & Bagshaw, 2019; Hu et al., 2016; Lane et al., 2016), and is expressed as diurnal variations in characteristics such as energy levels, affect, and both cognitive and physical performance (Facer-Childs, Boiling, & Balanos, 2018; Goldstein, Hahn, Hasher, Wiprzycka, & Zelazo, 2007; Mellow, Spoelstra, & Roenneberg, 2005; Miller et al., 2015).

Eveningness is associated with poorer outcomes for a wide range of major health issues. This includes all-cause mortality, as well as specific conditions such as arterial hypertension and type 2 diabetes (Au & Reece, 2017; Coleman & Cain, 2019; Knutson & von Schantz, 2018; Partonen, 2015; Selvi et al., 2012; P. M. Wong, Hasler, Kamarck, Muldoon, & Manuck, 2015). Considering mental health and mood, eveningness is associated with higher odds of lifetime depression, as well as increased depression symptom severity, in both clinical and non-clinical samples (Antypa, Vogelzangs, Meesters, Schoevers, & Penninx, 2016; Chan et al., 2014; Druiven et al., 2020; Hertenstein et al., 2019; Norbury, 2019; Park, Lee, & Lee, 2018; Selvi et al., 2012). Hidalgo et al. (2009) found E-types were five times more likely to have moderate–intense depressive symptoms than N-types in a nonclinical sample of adults. In clinical samples of people with depressive disorders, differences in depressive symptom severity due to chronotype tend to be even more pronounced (Gaspar-Barba et al., 2009; Selvi et al., 2010). E-types have also been found to have poorer rates of remission from major depressive disorder (Chan et al., 2014). Other mood- and affect-related outcomes have also been associated with chronotype. Lester (2015) found eveningness to be associated with increased perceptions of *defeat* and *entrapment* (negative feelings arising from an individual's experience of a “failed struggle”, and the perception that the defeat-generating situation cannot be resolved nor escaped; Gilbert & Allan, 1998) in a non-clinical sample of 194

undergraduate students. Additionally, E-types are at increased risk of suicidal ideation and behaviors (Bahk, Han, & Lee, 2014; Gau et al., 2007; Rumble et al., 2018; Sheaves et al., 2016). They are also more likely to attempt to die by suicide in a violent manner Selvi et al. (2011). These results taken together indicate that a person's chronotype may well play a significant role in mental health outcomes.

Eveningness is also associated with poorer sleep (Bakotic, Radosevic-Vidacek, & Bjelajac, 2017; Chan et al., 2014; Chiu, Yang, & Kuo, 2017). E-types struggle to adapt to typical societal rhythms related to work or school start times (Takahashi et al., 2011; Wittmann, Dinich, Merrow, & Roenneberg, 2006). They are also more likely to experience social jet-lag and associated chronic sleep deprivation (Haraszti, Ella, Gyöngyösi, Roenneberg, & Káldi, 2014; Roenneberg, Allebrandt, Merrow, & Vetter, 2012). Other examples of sleep disturbances that have been associated with eveningness and have consequences for waking life include increased risk for experiencing nightmares (Selvi et al., 2012) and greater sleep onset latencies (SOL; Barclay, Eley, Buysse, Archer, & Gregory, 2010). Specifically, this increase in SOL has been linked to a preference for activity in the evenings (Randler, Schredl, & Göritz, 2017) and later bedtimes in E-types (Crowley, Acebo, & Carskadon, 2007), in keeping with the increased risk of social jetlag in E-types. Increased SOL will therefore lead to chronic sleep deprivation if a person is obligated to rise at a relatively early time imposed by work or school schedules. This misalignment between endogenous and exogenous circadian rhythms typically prevents E-types attaining adequate quantities of sleep. Sleep deprivation is associated with depression (Conklin, Yao, & Richardson, 2018) and has also been found to have a causal relationship with increased levels of next-day suicidal ideation (Littlewood, Kyle, Pratt, Peters, & Gooding, 2017). This apparent effect of reduced total sleep time on affect is also compatible with the increased rates of depressogenic cognitions and rumination in E-types (Antypa et al., 2017). Although chronotype is partially dictated by genetic factors (Toomey, Panizzon, Kremen, Franz, & Lyons, 2015; Young & Kay, 2001) which may also influence affective traits, it is reasonable to assume that poor sleep mediates the chronotype–affect relationship. An example of evidence for this mediated causal relationship between poor sleep and negative affective outcomes is

provided by Chiu et al. (2017). Their study found that sleep quality mediated the relationship between chronotype and parental assessment of childhood depression. In sum, chronic sleep deprivation can be caused by a misalignment of social and biological circadian rhythms. In turn, this poor sleep quality appears to mediate the association between eveningness and negative affective outcomes in adolescents and young adults.

Chronotype is a trait appearing early in life, with detectable chronotype-related differences in affect appearing in children and infants (Chiu et al., 2017; Werner, LeBourgeois, Geiger, & Jenni, 2009). Significant intraindividual variation in chronotype occurs over the lifespan (Roenneberg et al., 2004), with a delay to circadian rhythms (i.e. a shift towards eveningness) typically occurring in adolescence. As such, the consequences of the mismatch between societal and individual rhythms for E-types may be amplified during later adolescence and early adulthood. The negative effect of this physiological delay on sleep quality is further worsened by young adults viewing sleep as low priority (Barone, 2017). This combined change in chronotype and sleep behaviors has significant negative effects on daily functioning and psychological well-being via their effects on sleep. Bakotic et al. (2017) found increased eveningness was associated with depressive mood in a sample of undergraduate students and sleep quality mediated the link between chronotype and depressive mood. Eveningness has also been associated with more severe suicide-related outcomes (Bahk et al., 2014; Rumble et al., 2018; Selvi et al., 2011, 2010). Work by Lester (2015) in a non-clinical sample of 194 undergraduate students also found eveningness to be associated with increased perceptions of defeat ($r = -.32$) and entrapment ($r = -.26$), both of which are strongly implicated in suicidal behavior (O'Connor, 2011; O'Connor & Kirtley, 2018; Williams, 2014; Winsper & Tang, 2014). However, Lester did not find an association between chronotype and past suicidal ideation nor suicide attempts. Further research into the eveningness–affect relationship is of particular importance in emerging adults given the high cost of mental ill health in this developmental phase Kessler et al. (2005); McGorry, Trethowan, and Rickwood (2019).

The present study aimed to explore the associations between chronotype and selected affective outcomes in a community sample of young adults. An additional aim was to explore the role of insomnia as a mediating factor in the chronotype–affect relationship.

Hypotheses

H1: Higher morningness will be associated with positive outcomes in measures of wellbeing and mental health.

H2: Insomnia will mediate the relationship between chronotype and affective outcomes where significant associations exist.

Method

Participants and Procedure

The study was designed in line with British Psychological Society guidelines. Ethical approval was granted by the University of Glasgow College of Science and Engineering Ethics Committee. Participants were recruited via social media, online forums, and university participant pool mailing lists. The only inclusion criterion was to be aged 18-24 years old. Participants completed an online survey during two data collection periods in different seasons (May–July 2019 and January–February 2020; N.B. data collection ended prior to COVID-19-related restrictions were placed on people's behaviors). The survey was described as being about sleep and its links to mood and/or mental health. Participants were provided with a link to a survey hosted on the University of Glasgow Experimentum platform (<https://exp.psy.gla.ac.uk>) which complies with the General Data Protection Regulation (EU) 2016/679. An information page with warnings about the sensitive nature of the topic was presented alongside contact details for mental health support services. After reading this page and providing consent, participants were asked to complete the measures described below. A debriefing page thanked participants and restated the contact details for support services.

Usable responses were obtained from 260 participants (170 female [65.3%], 89 male [34.2%], 1 other gender [0.4%]). The median age of the participants was 21 (IQR = 19–23)

years and the majority were students (202 students [77.6%], 45 employed [17.3%], 13 unemployed [5.0%]).

Measures

Demographics. Participants reported their age in years; their gender (male, female, or other); whether they primarily identified as students, employed, or unemployed; if they were in school, college, or university (if appropriate); and if they were in education full-time or part-time (if appropriate).

Chronotype. The reduced Morningness–Eveningness Questionnaire (rMEQ; Adan & Almirall, 1991; Loureiro & Garcia-Marques, 2015) is a five-item self-report measure of a person's chronotype and was selected for its brevity. Items include preferred awakening time, preferred time of day, and self-appraisal as a morning/neither/evening (M-, N-, E-) type. Scores can range from 4–25 with higher scores indicating increased morningness. The rMEQ prescribes five clusters of chronotype: definite M-types (22–25), moderate M-types (18–21), N-type (12–17), moderate E-types (8–11), and definite E-types (4–7). In the present study *definite* and *moderate* types were grouped together for categorical analysis. This is suggested by the authors of the scale for use during psychological research (Adan & Almirall, 1991) and has been done in previous studies using this scale (e.g., Akram et al., 2018; Hidalgo et al., 2009). Internal consistency of the rMEQ (and all other measures listed below) was assessed by Cronbach's (1951) α and McDonald's (1999) ω_t statistics: $\alpha = .57$, $\omega_t = .67$.

Insomnia. The Sleep Condition Indicator (SCI; Espie et al., 2014) is an 8-item measure of self-reported insomnia symptoms over the previous month. Each item is scored from 0–4, with higher scores indicating better sleep quality. It has good psychometric properties for detecting DSM-5 insomnia disorder and ICSD-3 chronic insomnia disorder, with a score of 16 or less (of a maximum of 32) indicating clinical level of dysfunction (Espie et al., 2014; M. L. Wong et al., 2017). Internal consistency in the present sample was $\alpha = .88$, $\omega_t = .91$.

Depression, Anxiety, and Stress. The 21-item short form of the Depression, Anxiety, and Stress Scales (DASS-21; Henry & Crawford, 2005; Lovibond & Lovibond, 1995) is a composite measure of depression, anxiety and stress symptoms. Participants respond to seven

questions for each of the three subscales using a four point Likert-type scale from 0 (*‘Did not apply to me at all’*) to 3 (*‘Applied to me very much or most of the time’*). These subscores are doubled to make comparable with the original 42-item version of the scale, and summed to give a total DASS-21 score. Potential scores for each subscale range from 0–42 and total scores from 0–126. Higher subscale scores respectively indicate more frequent or severe experiences of depression, anxiety, and stress symptoms. Internal consistency for overall DASS-21 scale in the present sample was $\alpha = .95$, $\omega_t = .96$. Internal consistency for subscales: $\alpha_{depression} = .93$, $\omega_{t, depression} = .95$; $\alpha_{anxiety} = .87$, $\omega_{t, anxiety} = .89$; $\alpha_{stress} = .87$, $\omega_{t, stress} = .92$.

Defeat. The defeat scale (Gilbert & Allan, 1998) comprises 16 mixed-valence statements related to subjective experiences of feeling defeated, humiliated, or having failed to achieve goals. Participants respond to statements such as *‘I feel that I am one of life’s losers’* using a five point Likert-type scale from *‘I never feel like this’* (0) to *‘I always feel like this’* (4). Potential scores ranges from 0–64, with higher scores indicating increased perceptions of defeat. Internal consistency in the present sample was $\alpha = .96$, $\omega_t = .96$.

Entrapment. The entrapment scale (Gilbert & Allan, 1998) comprises 16 statements related to subjective experiences of being unable to escape from or resolve situations in which an individual feels defeated or to have failed. Subscales measure feelings of entrapment triggered by internal (six items; e.g., *‘I would like to escape from my thoughts and feelings’*) and external causes (10 items; e.g., *‘I feel trapped by other people’*) entrapment. Responses are given using a five point Likert-type scale from *‘Not at all like me’* (0) to *‘Extremely like me’* (4). Potential scores range from 0–64, with higher scores indicating increased perceptions of entrapment. Internal consistency in the present sample was $\alpha = .96$, $\omega_t = .97$. Internal consistency for the internal entrapment subscale was $\alpha = .94$, $\omega_t = .96$. Internal consistency for the external entrapment subscale was $\alpha = .93$, $\omega_t = .96$.

Suicidal Ideation and Behaviors. The Suicidal Ideation Attributes Scale (SIDAS; van Spijker et al., 2014) is a 5-item combined measure of suicidal ideation and behaviors. It provides a brief assessment of the intensity of these outcomes over the previous month and their effects on daily functioning. Responses are provided to the five items using an 11 point

Likert-type scale ranging from 0–10. Each item has unique response anchors which are relevant to that item. For example, ‘*In the past month, how often have you had thoughts about suicide?*’ is anchored by ‘*Never*’ (0) and ‘*Always*’ (10). Potential scores range from 0–50 with higher scores indicating more frequent and/or severe suicide-related outcomes. van Spijker et al. (2014) suggest a cut-off score of 20 or higher to indicate suicide risk. The SIDAS was selected as it was designed to be completed without the need for clinical supervision and has minimal licensing restrictions. Internal consistency in the present sample for was $\alpha = .90$, $\omega_t = .92$.

Data Analysis

The dataset was screened by response time with listwise deletion applied if total response time was less than 25% of the mean time for the overall sample. Scalewise mean value replacement was applied on a per-participant, per-scale basis if the respondent missed a single item on any of the DASS-21 subscales or the SCI. This was also applied on a per-participant, per-scale basis if the respondent missed up to two items from the defeat and entrapment scales. Listwise deletion was applied otherwise, including if consent had not been obtained or any questions were missed on scales not mentioned above. This resulted in a final sample of 260 respondents with complete data. Outliers were not removed as it is individuals reporting extremely negative outcomes that are of greatest relevance to the research question.

Data was analyzed using RStudio version 1.4.634 (RStudio Team, 2020) built on R version 3.6.3 (R Core Team, 2020). Normality of data was assessed by Shapiro–Wilk tests and all measures were found to deviate from normality. Therefore, nonparametric statistical methods were used throughout the analysis. H_1 was assessed using bivariate Kendall’s τ_b rank correlations and Mann-Whitney U tests. H_2 was tested using serial multiple mediation analysis. Note that use of mediation analysis on cross-sectional data must be justified based on existing theory (Fairchild & McDaniel, 2017; Shrout & Bolger, 2002): The role of insomnia as a mediating factor between sleep disturbance and affective outcomes is justified by studies such as those by Chiu et al. (2017) and Simor, Zavecz, Pálosi, Török, and Köteles (2015) as well as other literature discussed above. Mediation analysis was carried out using the *lavaan*

R package (v.0.6-3) and nonparametric bootstrap resampling techniques (Rosseel, 2012; Shrout & Bolger, 2002). Bootstrapping was carried out with 50,000 bootstrap iterations. This value was used due to variation in the bounds of the 95% confidence intervals chronotype–insomnia regression point estimates for different outcomes (lower: 0.50–0.53, upper: 1.25–1.30) after the literature-standard 5,000 iterations. Holm-Bonferroni corrections (Holm, 1979) were applied to correlations and Mann-Whitney U tests; for practical reasons these two methods were treated as separate families of tests.

Results

The sample comprised 44 M-types (16.9%), 133 N-types (51.2%), and 83 E-types (31.9%). One hundred and eight participants met the cut-off score for probable insomnia disorder (41.5%). Self-reported chronotype (Q5 in rMEQ) was moderately correlated with the sum of items Q1–4 on the rMEQ ($r = 0.45, p < 0.001$). Descriptive statistics are presented in Table 1 with bivariate association coefficients (Kendall's τ).

TABLE 1 ABOUT HERE.

Groupwise comparisons

Kruskal-Wallis tests indicated significant differences between chronotype groups on all outcome measures but showed no difference in age. Subsequent Mann-Whitney U tests showed no significant differences between M- and N-types except for chronotype. However, E-types had significantly poorer scores for all outcomes compared to both M- or N-types (see Tables 2 and 3). These results show that eveningness is associated with more severe psychological distress and poorer sleep.

TABLES 2 AND 3 ABOUT HERE

Mediation Analysis

Mediation analysis with chronotype as the independent variable and insomnia as the mediator showed this indirect pathway to be significant for all outcome variables (see Figure 1 and Table 4). For both stress and suicide, the inclusion of insomnia as a mediator rendered the

direct effect of chronotype on these outcomes insignificant. This suggests that the poorer affective outcomes associated with eveningness may be at least partially explained by the poor sleep experienced by E-types

FIGURE 1 ABOUT HERE.

Discussion

This study examined the relationship between chronotype and affective outcomes, as well as the the mediating role of insomnia symptoms in a sample of emerging adults. Our analyses provides nearly complete support for H1: increased eveningness was negatively associated with all outcome measures with the exception of stress. Additionally, results of the mediation analyses provide partial support for H2: insomnia partially mediated significant proportions of the total effect of chronotype on affective outcomes. These results combine to suggest that E-types are at an increased risk of poorer mental health outcomes, but this risk may be attributed to the negative effects of poor sleep quality.

The results and effect sizes found in the present study are in keeping with existing literature on the chronotype–affect relationship (e.g., Bakotic et al., 2017; Simor et al., 2015; You, Laborde, Dosseville, Salinas, & Allen, 2020). The poorer affective outcomes of E-type in the present sample reflect the results of Tan et al. (2020) from their sample of undergraduates where E-types score lower on a measure of happiness than N- and M-types. Similarly, our mediation analyses complement that of (Chiu et al., 2017) where sleep quality mediated the chronotype–depression relationship. The role of insomnia as a mediating factor between chronotype and negative emotionality found by Simor et al. (2015) in their sample of adults (mean age = 25.3 ± 5.8 years) was also confirmed in the present study. However, our results show that the mediating role of sleep quality in the relationship between chronotype and depression/stress appears to extend to a broader range of affective outcomes. These outcomes include perceived defeat and entrapment, as well as suicidal ideation.

Our findings — combined with the broader literature — suggest that an evening chronotype is not a solely intrinsic source of negative affect. The poorer outcomes most often associated with higher eveningness are partially consequences of poor sleep quality related to

this preference for evenings. This poor sleep is a result of misalignment of preferred daily rhythms and external constraints such as school and work schedules. This is in keeping with findings such as those of Dimitrov et al. (2018) where depressive mood was associated with sleep mid-point on work/school days but not on days where participants had fuller control over their schedule (i.e. weekends and holidays). The implications of these findings are that the negative outcomes associated with being an E-type can be mitigated. Individuals that have increased control over their schedules can plan later start times for their days and work at times when their motivation and energy are high. As young adults leave the education system they face challenges related to finding employment and beginning to develop careers. However, they gain the opportunity to potentially create a daily structure more suited to their endogenous circadian preferences (e.g. by working late shifts or finding employers supportive of flexible working hours; although this may not be an option for the most deprived groups of society that lack the privilege of employment choices). This freedom can also allow them to harness potential protective factors against negative affect. For example, E-types high in trait extraversion can benefit from engaging in social occasions which typically take place later in the day, a time when they feel their best (Drezno, Stolarski, & Matthews, 2019). By aligning internal and external daily rhythms, the link between eveningness and negative mental health outcomes can be mitigated.

Alternatively, if the alignment of internal and external rhythms cannot be achieved then we can look to behavioral change for improvement in affective outcomes. The abundance of research into treatment of insomnia and delayed sleep-wake phase disorder has produced a number of behavior-modifying approaches including clinically-effective cognitive-behavioral therapies for insomnia (CBTI) interventions (Trauer, Qian, Doyle, Rajaratnam, & Cunnington, 2015; van der Zweerde, Bisdounis, Kyle, Lancee, & van Straten, 2019). However, chronotype may act as a moderator on the effectiveness of CBTI. Bei, Ong, Rajaratnam, and Manber (2015) examined the effect of a six-week group CBTI for insomnia intervention in an outpatient clinical sample of people experiencing insomnia. Their results showed significantly smaller improvement in depressive mood in E-types than N-types, with N-types in turn showing significantly smaller improvement than M-types. In contrast, an internet-based CBTI

intervention study using midlife adults by Lien et al. (2019) found similar improvements in depressive mood and insomnia severity in both M- and E-types. Further exploration of the interaction of CBTI-effectiveness and chronotype is required. Combined with the knowledge that lifelong health-behavior change can be effectively implemented by altering automatic and habitual behaviors during emerging adulthood (e.g., Cleo, Isenring, Thomas, & Glasziou, 2017), E-types may benefit more from approaches focussed on maintaining habitual good sleep hygiene routines if CBTI is less effective in this group. Although chronotype is partially defined by genetics, it is possible to modify through behavioral interventions. Modifying sleep–wake behaviors can thus mitigate some of the consequences of being an E-type bound to societal schedules related to a conventional 9–5 work day. Facer-Childs et al. (2019) carried out a randomised control trial of advancing sleep–wake timings by approximately two hours in a sample of E-types. Compared to the control group (also E-types) that received no intervention, the treatment group experienced significant improvements in measures of depression and cognitive performance. The intervention was relatively unintrusive, mainly focussing on timing of meals, exercise, and light exposure. Additionally, even less intensive interventions based on sleep-related psychoeducation may bring about similar changes in sleep behaviors of young adults and adolescents high in eveningness (Harvey et al., 2018). Chung, An, and Suh (2019) found that higher eveningness was associated with increased bedtime procrastination (e.g. TV watching) in young adults, highlighting a potential daily opportunity to improve sleep quality through habit formation or modification. In sum there are multiple existing methods for improving sleep quality which can mitigate the suggested negative effect of eveningness on affective outcomes.

Chronotype in the present study was measured using the short form of the Morningness–Eveningness questionnaire. This measures asks about a person’s activity preferences on free days (i.e. those where sleep-wake times are not dictated by external factors such as work or school). A more in-depth analysis of misalignment between externally-dictated sleep–wake/energy schedule requirements and personal preferences would provide more insight into the role of chronotype and sleep disturbance on affective outcomes. Comparison of school/work days with free days could be made by using an alternative

measure of circadian preference such as the Munich Chronotype Questionnaire (Roenneberg et al., 2003). Analysis of the differences between free and constrained days could explore potential dose–response relationship in term of rhythm misalignment. This is would build on work by You et al. (2020) found that the amplitude of variation in energy and motivation across the course of the day was a much stronger correlate with stress than chronotype directly ($r = .39$ and $.14$, respectively). Again, a more detailed exploration of the potentially multifactorial nature of chronotype (Konttinen et al., 2014; Preckel et al., 2019; Putilov, 2017; Putilov, Donskaya, & Verevkin, 2015; Putilov, Marcoen, Neu, Pattyn, & Mairesse, 2019) may generate more interesting and useful results for how to handle negative affective consequences of circadian rhythm misalignment. As highlighted in a review by Taylor and Hasler (2018), future studies of chronotype will ideally include more prospective research and increased use of objective sleep and wake measurements.

A strength of this study is the use of validated measures throughout. The use of validated measures for sleep quality and suicidal ideation addresses the specific criticism of sleep-related suicide research made by Tubbs, Perlis, and Grandner (2019) which was that too often only single-item measures are used for these constructs. Another strength of this study is the broadening of outcomes to include more than depression, which is commonly the only outcome assessed in similar studies related to chronotype. If circadian/social rhythm misalignment leads to negative effects on a variety of mental health outcomes (as opposed to depression or mood alone) then correction of this misalignment offers a simple and practical transdiagnostic intervention. Further, if the causative role of this misalignment — and its effects on sleep — can be established by prospective studies, then the underlying pathways can be better understood.

This cross-sectional study cannot inform the direction of potential causal pathways between eveningness and negative affective outcomes. Particular caution around presumptions of this directionality must be exercised due to the complex and idiopathic relationships between sleep–wakefulness and affective outcomes such as depressive symptom severity. However, research on insomnia’s effect on subsequent mood and mental health outcomes (e.g., Bernert, Hom, Iwata, & Joiner, 2017; Littlewood et al., 2019) combined with research

on chronotype's causal association with poor sleep quality points towards a directional chronotype–insomnia–affect pathway (Bakotic et al., 2017; Facer-Childs et al., 2019; Konjarski, Murray, Lee, & Jackson, 2018). This putative causal relationship is supported by the results of the present study. Additional prospective research is needed to better establish this pathway. Preferably this would include objective sleep–wake behavior tracking along with ecological momentary assessment studies that measure affect and circadian-informed variables (e.g. energy levels, motivation, sleepiness) coincidentally. Additionally, as insomnia provides only partial mediation of the chronotype–affect relationship, other explanatory factors must also be investigated to better resolve the association of eveningness with poorer mental health outcomes.

Conclusion

This study has shown that eveningness is associated with poorer affective outcomes during emerging adulthood. It has also demonstrated the potential role of insomnia as a mediating factor within this relationship. Taken together, these findings have the potential to improve the assessment and prevention of psychological distress in young adults who report a preference for later sleep and wake times. Our results suggest that interventions that target insomnia and sleep-related behavior change have the potential to mitigate the effect of poor sleep quality related to misalignment of internal and external rhythms in this population. Ultimately these interventions may protect against or mitigate a range of negative affective outcomes in young adults.

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Tables

	1.	2.	3.	4.	5.	6.	7.	8.	9.	Median	IQR
1. Age										21	19–23
2. Insomnia	0.01									18	12–25
3. Chronotype	0.07	0.24***††								13	10–16
4. DASS-21	-0.11	-0.48***	-0.23***††							36	16–64
5. Depression	-0.12	-0.44***	-0.24***††	0.74***						10	4–22
6. Anxiety	-0.11	-0.43***	-0.20***†	0.72***	0.50***					10	2–20
7. Stress	-0.06	-0.43***	-0.17***NS	0.76***	0.53***	0.60***				14	8–24
8. Defeat	-0.11	-0.43***	-0.22***††	0.59***	0.67***	0.46***	0.44***			20	12–34
9. Entrapment	-0.09	-0.40***	-0.27***	0.63***	0.69***	0.49***	0.50***	0.67***		15	5–30
10. Suicide	-0.06	-0.39***	-0.15*NS	0.52***	0.54***	0.44***	0.40***	0.54***	0.55***	4	0–15

Table 1

Descriptive statistics and bivariate associations assessed using Kendall's τ coefficients. Crude significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Significance levels following Holm-Bonferroni correction remained mostly unchanged. Where significance levels changed these are indicated with the following superscripts: † $p < 0.05$, †† $p < 0.01$, NS no longer significant. Note: Age was not significantly associated with any measure either pre- or post-correction.

	M-types (N = 44)		E-types (N = 83)		U	r
	Mdn	IQR	Mdn	IQR		
Chronotype ^{***†††}	19	18–20	9	8–10	0	0.83
Insomnia ^{***†††}	21	16.75–26.25	12	9.5–18.5	982.5	0.38
DASS-21 ^{***††}	21	14–55	56	28–83	2594	0.35
Depression ^{***††}	5	2–13.5	20	8–31	2573.5	0.34
Anxiety ^{***††}	6	2–16	16	8–24	2502.5	0.3
Stress ^{**†}	12	7.5–20.5	18	12–30	2400	0.26
Defeat ^{***††}	18	10.75–27.75	31	17.5–44	2551	0.33
Entrapment ^{***†††}	7.5	1–25.25	28	12.5–41	2698	0.39
Suicide ^{*NS}	2.5	0–15.5	11	2–25	2270	0.2

Table 2

Two-tailed Mann–Whitney U test statistics for M-types v. E-types. Note. Mdn = median, IQR = interquartile range, U = Mann Whitney U test statistic, r = effect size ($|Z|/\sqrt{N}$; Field, Miles, & Field, 2012). Crude significance levels of between-group differences: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Significance levels following Holm-Bonferroni correction (corrected for 27 tests; three pairwise comparisons $\times$ nine variables): ^{NS} no longer significant, [†] $p < 0.05$, ^{††} $p < 0.01$, ^{†††} $p < 0.001$.

	N-types (<i>N</i> = 133)		E-types (<i>N</i> = 83)		<i>U</i>	<i>r</i>
	<i>Mdn</i>	<i>IQR</i>	<i>Mdn</i>	<i>IQR</i>		
Chronotype ^{***†††}	14	13–15	9	8–10	0	0.84
Insomnia ^{***†††}	21	15–26	12	9.5–18.5	2913	0.4
DASS-21 ^{***†††}	28	16–54	56	28–83	7519	0.3
Depression ^{***†††}	8	4–18	20	8–31	7433.5	0.29
Anxiety ^{***†††}	8	2–16	16	8–24	7417.5	0.29
Stress ^{**†}	14	8–22	18	12–30	6948.5	0.22
Defeat ^{***†††}	17	11–29	31	17.5–44	7690	0.33
Entrapment ^{***†††}	12	5–21	28	12.5–41	7875.5	0.36
Suicide ^{***†††}	2	0–10	11	2–25	7443	0.3

Table 3

Two-tailed Mann–Whitney *U* test statistics for *N*-types v. *E*-types. Note. *Mdn* = median, *IQR* = interquartile range, *U* = Mann Whitney *U* test statistic, *r* = effect size ($|Z|/\sqrt{N}$; Field et al., 2012). Crude significance levels of between-group differences: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Significance levels following Holm-Bonferroni correction (corrected for 27 tests; three pairwise comparisons $\times$ nine variables): NS no longer significant, † $p < 0.05$, †† $p < 0.01$, ††† $p < 0.001$.

Outcome	<i>a</i>	<i>b</i>	<i>a</i> × <i>b</i>	<i>c</i> '	<i>c</i> ' + <i>a</i> × <i>b</i>	<i>P_M</i> (%)
DASS-21	0.66 (0.42, 0.89)	-2.41 (-2.72, -2.07)	-1.59 (-2.19, -1.03)	-0.94 (-1.66, -0.236)	-2.53 (-3.46, -1.60)	62.8)
Depression	0.66 (0.42, 0.89)	-0.87 (-1.01, -0.71)	-0.57 (-0.81, -0.36)	-0.53 (-0.86, -0.20)	-1.10 (-1.47, -0.71)	51.9
Anxiety	0.66 (0.42, 0.89)	-0.74 (-0.86, -0.62)	-0.49 (-0.68, -0.31)	-0.31 (-0.57, -0.04)	-0.80 (-1.11, -0.47)	61.4
Stress	0.66 (0.42, 0.89)	-0.80 (-0.92, -0.67)	-0.53 (-0.73, -0.33)	<i>-0.10 (-0.37, 0.17)</i>	-0.63 (-0.97, -0.29)	83.6
Defeat	0.66 (0.42, 0.89)	-1.12 (-1.28, -0.96)	-0.74 (-1.04, -0.47)	-0.51 (-0.91, -0.12)	-1.25 (-1.72, -0.77)	59.0)
Entrapment	0.66 (0.42, 0.89)	-1.09 (-1.28, -0.89)	-0.72 (-1.01, -0.46)	-0.89 (-1.36, -0.43)	-1.61 (-2.14, -1.09)	44.5
Suicide	0.66 (0.42, 0.89)	-0.83 (-1.01, -0.65)	-0.54 (-0.78, -0.35)	<i>-0.14 (-0.51, 0.24)</i>	-0.68 (-1.11, -0.25)	79.7

Table 4

Bootstrapped point estimates and 95% bias-corrected confidence intervals (in parentheses) for direct and indirect effects as represented in Fig. 1. Note. Point estimates and 95% confidence intervals of indirect and direct pathways resulting from multiple serial mediation analysis. Generated using 50000 bootstrapping iterations. Italics indicate insignificant relations (i.e where confidence intervals include zero). P_M = proportion mediated as percentage of total effect size = $a \times b / (c' + a \times b)$.

Figures *Figure 1.*

Figure Captions

1. Mediation model for chronotype and outcomes via insomnia.