Original Article

The slow and fast life histories of early birds and night owls: their future- or present-orientation accounts for their sexually monogamous or promiscuous tendencies

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ABSTRACT

In this study we tested the hypothesis that inter-individual variation in morningness–eveningness (i.e., chronotype) is associated with variation in a composite measure of life history (the mini-K) such that morning-types (i.e., early birds) exhibit traits typically associated with slow life histories while evening-types (i.e., night owls) exhibit traits typically associated with fast life histories. In addition, we tested the hypothesis that time perspective may be one of the psychological mechanisms mediating the relationship between chronotype and socio-sexuality. Study participants were 95 heterosexual young men, most of whom were university students. Chronotype, life-history traits, socio-sexuality, and time perspective were assessed with well-established self-report measures. Variations in chronotype and in life-history traits were significantly associated in the direction predicted by our hypothesis. Consistent with our second hypothesis, time perspective emerged as a significant mediator of the association between chronotype and socio-sexuality so that the future orientation of morning-types was associated with their long-term mating orientation and relatively low sexual experience, while the present orientation of evening-types was associated with their short-term mating orientation and greater sexual experience. Our study provides the first evidence that variation in chronotype may be adaptive and elucidates one of the psychological mechanisms underlying the life history and reproductive strategies of male early birds and night owls.

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1. Introduction

Circadian rhythms are widespread across organisms, from bacteria to animals, have evolved independently multiple times, and have adaptive value that is bound to the cyclical variation of stimuli and resources necessary for survival and reproduction (DeCoursey, 2004). In humans there is considerable inter-individual variation in behavioral circadian rhythms, and such variation can be reliably identified with self-reported measures of diurnal activity patterns, such as wake/sleep times and the timing of peak cognitive performance (Horne & Östberg, 1976, 1977). Using this approach it has been shown that people's sleep patterns are normally distributed, with approximately 30% of individuals falling at the two extremes (Adan et al., 2012). At one extreme of the distribution, morning-types (or early birds) prefer early wake-up and sleeping times, reach maximum alertness soon after waking up, and have cognitive performance peaks early during the day. At the other extreme, evening-types (or night owls) are characterized by late wake-up and sleeping times and by their preference for being active in the evening. In a given population, approximately 70% of individuals have sleep pattern preferences intermediate between those of early birds and night owls (see Adan et al.,

2012, for a review). Sleep pattern preferences, also known as chronotype, appear to be stable over time (Hur, 2007), are moderately heritable (Hur & Lykken, 1998; Klei et al., 2005), and are sexually dimorphic, as men tend to be overrepresented among evening types (Randler, 2007). The sex differences in chronotype are minimal before puberty and after women's menopause (Randler & Bausback, 2010; Roenneberg et al., 2004) and, similarly to other sexually dimorphic traits, may be under the influence of gonadal steroids (Hastings Hagenauer & Lee, 2012).

Many physiological, psychological, and behavioral differences have been reported between morning- and evening-types (see Adan et al., 2012, for a review). Physiologically, the melatonin peak, temperature nadir, and cortisol peak all occur at an earlier time in morning-types compared to evening-types (e.g., Kerkhof & Van Dogen, 1996). In terms of personality traits, evening-types generally score high in extraversion (Díaz-Morales, 2007; Matthews, 1988; Randler et al., 2012) and in the dark triad traits (i.e., Machiavellianism, secondary psychopathology and exploitive narcissism; Jonason, Jones, & Lyons, 2013), while morning-types appear to be more conscientious and agreeable (Tsaousis, 2010), more cooperative with others (Díaz-Morales, 2007), more persistent in accomplishing their goals (Caci et al., 2005), and score higher in the personality meta-trait of stability (DeYoung, Hasher, Djikic, Criger, & Peterson, 2007). Evening-types also score higher than morning-types in impulsivity, novelty-seeking, and risk-taking (Caci, Robert, & Boyer, 2004; Caci et al., 2005; Killgore, 2007; Maestripieri,

2014; Muro, Gomà-i-Freixanet, & Adan, 2012; Tonetti et al., 2010). Finally, evening-types are less sociosexually restricted (in women: Jankowski, Diaz-Morales, Vollmer, & Randler, 2014) and report a higher number of life-time sexual partners than morning-types (in men: Piffer, 2010; Piffer, Gunawardane, & Custance, 2011; Randler et al., 2012). Although the functional significance of chronotype-related variation in physiological, psychological, and behavioral traits has not been systematically addressed, life history theory can potentially provide a powerful framework for understanding this variation from a functional and evolutionary perspective.

A large body of research guided by life history theory has shown that inter-individual variation in human growth and sexual maturation as well as in socio-sexual behavior and reproduction is far from random. Rather, much of this variation can be functionally explained in terms of distinct survival and reproductive strategies such as those collectively known as slow and fast life histories. Slow life histories are characterized by trade-offs favoring maintenance over growth, future over current reproduction (e.g., delayed sexual maturation), monogamous rather than promiscuous sexual relationships, and offspring quality over quantity (i.e., low offspring number and high parental investment) (e.g., Del Giudice, 2009; Del Giudice & Belsky, 2011; Ellis, 2004; Kaplan & Gangestad, 2005). In contrast, individuals who adopt fast life-history strategies are more likely to sexually mature and to start mating early in life, mate frequently, and invest relatively little in relationships and children (Belsky, Steinberg, & Draper, 1991).

Although life-history strategies refer mainly to growth- and reproduction-related traits, they also include a broad range of physiological, psychological, and behavioral traits, such as arousability and stress reactivity, personality, novelty-seeking and risk-taking, altruism and cooperation, and romantic attachment styles (e.g., Del Giudice, 2009, 2014; Del Giudice & Belsky, 2011; Kaplan & Gangestad, 2005). For example, Figueredo et al. (2006, 2005) identified a cluster of interrelated traits, in which conscientiousness, agreeableness and stability are positively correlated with restricted sociosexuality, high risk aversion, and prosocial behaviors, which appears to represent a slow life history strategy (the "K-factor").

Time perspective has been suggested to be central to life history strategies as it may influence the trade-off between current and future reproduction (Chisholm, Quinlivan, Petersen, & Coall, 2005). Individuals on a slow life history strategy are expected to be more future oriented, self-controlled, and to delay gratification, while individuals on a fast life history should be more present-oriented, be more impulsive, and seek immediate gratification (Del Giudice, 2014). Consistent with this view, the psychological construct of future time perspective developed by Zimbardo and Boyd (1999), which measures an individual's tendency to strive for future goals, has been found to mediate the relationship between the quality of the early socioecological environment and later tendencies toward risky behaviors, so that exposure to harsh early environments makes individuals more present-oriented; this in turn, increases their propensities to take risks (Kruger, Reischl, & Zimmerman, 2008; see also Nowack, Milfont, & van der Meer, 2013; Simons, Vansteenkiste, Lens, & Lacante, 2004, for other cognitive and motivational aspects of individual differences in time perspective).

Based on previous research on the physiological, psychological, and behavioral differences between morning- and evening-types as well as on the hypothesis that eveningness may have evolved to facilitate short-term mating (Piffer, 2010; see also Maestripieri, 2014), we hypothesize that the two distinct clusters of traits that are generally associated with morningness and eveningness are best understood as expressions of slow and fast life history strategies, respectively. From this hypothesis, we derived and tested the prediction that continuous variation in sleep pattern preferences (as assessed with a reliable self-report measure of chronotype, the reduced Morningness–Eveningness Questionnaire, or rMEQ; Adan & Almirall, 1991) should be significantly associated with a psychometric measure of life history such as the mini-K (Figueredo et al., 2005, 2006), so that the psychological and behavioral

traits typical of slow life histories should be highest in morning-types, whereas the traits typical of fast life histories should be highest in evening-types.

One of the key behavioral differences between individuals on slow and fast life histories concerns their socio-sexuality. Consistent with the theory and with previous findings, restricted socio-sexuality is associated with slow life histories while unrestricted socio-sexuality is associated with fast life histories (Ellis, 2004). One of the predictions derived from our hypothesis, therefore, is that morning- and evening-types should exhibit restricted and unrestricted socio-sexuality, respectively (see Jankowski et al., 2014, for evidence that this is the case in women). Based on recent studies on the relationship between chronotype and time perspective, which show links between morningness and future orientation, and between eveningness and present orientation (Díaz-Morales, Ferrari, & Cohen, 2008; Milfont & Schwarzenthal, 2014; Stolarski, Ledzinska, & Matthews, 2013), we also hypothesized that time perspective may be the psychological mechanism underlying the link between chronotype and socio-sexuality. To test this hypothesis we conducted a mediation analysis to assess whether a well-established measure of time perspective, the Zimbardo's Time Perspective Inventory (ZTPI; Zimbardo & Boyd, 1999) could statistically mediate the association between a measure of chronotype (the rMEQ) and one of socio-sexuality (including short-term vs. long-term mating orientation), the Multidimensional Sociosexual Inventory (MSOI; Jackson & Kirkpatrick, 2007). The predictions tested with this analysis are that morning-types are more long-term mating oriented and more sociosexually restricted because they are more future-oriented, while evening-types are more short-term mating oriented and less sociosexually restricted because they are more present-oriented.

2. Methods

2.1. Participants and procedure

Participants were 96 young men (mean age = 22.40 years; SD = 3.89, SE = 0.39) recruited on the University of Chicago campus through fliers, mailing lists, or a human subject recruitment website (Sona System). The majority of the participants were students at the University of Chicago. All study participants completed a written informed consent form before participating in the study and were paid $20 after completion of the procedures. This study and the use of human subjects were approved by the Social Sciences Institutional Review Board of the University of Chicago. An initial demographic survey asked information about participants' age, ethnicity, sexual orientation, and marital or relationship status (single or in a relationship). One of the 96 participants reported a homosexual orientation and was excluded from data analyses. Of the 95 heterosexual participants, 61.5% were Caucasian, 10.4% were Hispanic, 9.4% were African-American, 7.3% Asian, and the rest were of other ethnicities. Ninety-three of the participants had never been married, while one was separated and one was divorced. Of the participants who reported their current relationship status (n = 86), 46% of them were currently involved in a romantic relationship, and the others were single. In terms of previous sexual experience, 15 out of the 95 participants (16%) never had sexual intercourse, 15 (16%) had intercourse with only one woman, and the others (68%) had intercourse with multiple women (range 2–100).

2.2. Measures

Following the demographic survey, other questionnaires were administered. For the purposes of this study, the following four questionnaires were considered:

Reduced version of the Morningness–Eveningness Questionnaire (rMEQ). We assessed chronotype with the reduced version of the Morningness–Eveningness Questionnaire (rMEQ) (Adan & Almirall,

1991). The rMEQ is a validated, 5-item Likert-type scale obtained from the original 19-item version of the MEQ (Horne & Östberg, 1976). The rMEQ identifies the participants' preferences in relation to sleeping and waking time, the time of day when they experience maximal efficiency, their level of tiredness within half an hour of awakening, and their self-perceived chronotype (see Adan & Almirall, 1991). Scores for the rMEQ range from 4 to 25; scores below 12 identify participants as evening-types and scores above 17 as morning-types. The psychometric properties of the rMEQ have been reviewed by Chelminski, Petros, Plaud, and Ferraro (2000) and by Di Milia, Adan, Natale, and Randler (2013), who concluded that this scale has high reliability and produces results that are highly correlated with those of the original MEQ and other commonly used scales. The Cronbach's α coefficient for the present study was 0.70.

Mini-K. The Mini-K (Figueredo et al., 2005, 2006) is a 20-item questionnaire with a 7-point Likert-type scoring developed to measure behavioral and cognitive aspects of life history strategies. This questionnaire is a short form of the Arizona Life History Battery (ALHB) and includes items such as "While growing up I had a close and warm relationship with my biological father" and "I would rather have one than several sexual relationships at a time". For the present sample the Mini-K showed a Cronbach's α coefficient of 0.77.

The Multidimensional Sociosexual Inventory (MSOI). The MSOI (Jackson & Kirkpatrick, 2007) is a 23-item measure of sociosexual orientation and behavior. It is comprised of two attitudinal scales with 7-point Likert-type items that measure short-term (STMO) and long-term (LTMO) mating orientation, and one scale that measures past sexual experience (PSE). In the present study the Cronbach α were 0.93, 0.88, and 0.74 for STMO, LTMO and PSE, respectively. The PSE includes three questions about the lifetime number of sexual partners, the lifetime number of casual sexual partners, and the number of sexual partners in the previous year.

Zimbardo's Time Perspective Inventory (ZTPI). The ZTPI (Zimbardo & Boyd, 1999) is a 56-item questionnaire that assesses 5 dimensions of psychological time. In the present study we used only the items representative of 3 dimensions: Future Time Perspective (ZTPI-F), Present Hedonistic (ZTPI-PH), and Present Fatalistic (ZTPI-PF). The ZTPI-F measures a general future orientation and includes items such as "I am able to resist to temptations when I know that there is work to be done". The ZTPI-PH measures an impulsive, hedonistic and risk-taking attitude toward life, and it includes items such as "I do things impulsively". The ZTPI-PF represents a fatalistic view of the future, and it includes items such as "My life path is controlled by forces I cannot influence". Cronbach's α were 0.62, 0.82 and 0.63 for ZTPI-F, ZTPI-PH and ZTPI-PF, respectively.

2.3. Statistical analysis

Pearson's bivariate correlations were used to investigate possible covariation between the variables under study. Regression analyses were used to investigate the mediation of ZTPI-F between the rMEQ and the three domain of sociosexuality using Haye's PROCESS macro for SPSS (Hayes, 2008). This approach uses a bootstrapping method to construct confidence intervals for the indirect effect. Where possible, the kappa squared (κ^2) (Preacher & Kelley, 2011) was used as a measure of effect size for the indirect effect. κ^2 is a standardized measure bounded between 0 and 1 and independent of sample size, which has similar effect size interpretation as the squared correlation coefficient R^2, where 0.01 would be considered a small effect, a 0.09 medium effect, and 0.22 a large effect size. All statistical analyses were carried out with SPSS 22.

3. Results

Twenty-six participants were classified as evening-types, 10 as morning-types, and 59 as neither type. In agreement with previous studies, chronotype was normally distributed, and the rMEQ average score (mean $\pm$ SE) was 13.71 $\pm$ 0.34. The average score for the Mini-K was 4.88 $\pm$ 0.07, for the STMO was 4.85 $\pm$ 0.15, for the LTMO was 5.94 $\pm$ 0.09 and for past sexual experience was 3.98 $\pm$ 0.70. The average scores for the three time perspective measures were as follows: ZTPI-PH = 3.40 $\pm$ 0.05, ZTPI-PF = 2.47 $\pm$ 0.05, ZTPI-F = 3.47 $\pm$ 0.05.

Table 1 reports the descriptive statistics and zero-order correlations between the variables studied. Chronotype was positively correlated with age, indicating that older subjects tended to be more morning-oriented. Age was also positively correlated with previous sexual experience, but not with any of the other variables. There were no significant effects of ethnicity or relationship status on any of the dependent variables of interest in this study.

3.1. Chronotype, life history, and time perspective

The rMEQ score was positively associated with the Mini-K score (see Table 1), indicating that morning-types show a slow life history strategy. The rMEQ score was negatively correlated with STMO, indicating that evening-types are oriented toward short-term mating. Moreover, the rMEQ score was positively correlated with ZTPI-F and negatively with ZTPI-PF indicating that morning-types are more future oriented and have less of a fatalistic attitude than evening-types.

3.2. Mediation analysis

To test the hypothesis that time perspective, and more specifically future orientation, mediates the relationship between chronotype and sociosexuality, we ran three regression analyses: one with short-term mating orientation, one with long-term mating orientation, and one with past sexual experience as dependent variables. In all three regressions, time perspective was used as the predictor. Age was entered as a covariate in the model with previous sexual experience; chronotype was entered as a continuous variable.

The regression model with short-term mating orientation was statistically significant ($R^2 = 0.10$, p = 0.01, see Table 2). Likewise, the indirect effect was significant (Fig. 1a, ab = −0.02, 95% CI [−0.070, −0.003], $\kappa^2 = 0.05$). These results indicate that morning-types are less prone to short-term mating as a consequence of being more future oriented. Similarly, the regression model with long-term mating orientation was significant ($R^2 = 0.06$, p < 0.05). In this model time perspective mediated the relationship between chronotype and sociosexual attitudes, such that the morning-types, being more future oriented, showed more interest in long-term sexual/romantic relationships (Fig. 1b, ab = 0.01, 95%CI [0.0005, 0.05], $\kappa^2 = 0.05$). Lastly, for the model with past sexual experience ($R^2 = 0.25$, p < 0.01, Table 2) the indirect effect was statistically significant (Fig. 1c, ab = −0.15, 95% CI [−0.53, −0.01]), which indicates that morning-types are more restricted in their sexual behavior as a consequence of being more future oriented.

4. Discussion

In our subject population of 95 adult males, chronotype was normally distributed (10 participants were classified as morning-types, 26 as evening-types, and 59 as neither type), and continuous variation in our measure of chronotype (the rMEQ) was significantly correlated with variation in a psychometric measure of slow life history, the mini-K (Figueredo et al., 2005, 2006). This correlation indicates that participants who were higher in morningness showed psychological and behavioral traits typical of slow life histories, while participants who were higher in eveningness showed traits typical of fast life histories.

Table 1
Descriptive statistics and bivariate correlations.

	Mean (SD)	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Age	22.40 (3.89)	–								
2. r-MEQ	13.71 (3.39)	0.25**	–							
3. Mini-K	4.88 (0.71)	0.05	0.24*	–						
4. LTMO	5.94 (0.94)	−0.03	0.07	0.46**	–					
5. STMO	4.85 (1.46)	−0.03	−0.20*	−0.28**	−0.24*	–				
6. PSE	3.98 (0.70)	0.38**	0.05	−0.22*	−0.13	0.50**	–			
7. ZTPI-PH	3.40 (0.05)	0.01	−0.08	0.05	0.06	0.35**	0.24**	–		
8. ZTPI-PF	2.47 (0.05)	0.12	−0.25**	−0.34**	−0.15	0.40**	0.21*	0.18	–	
9. ZTPI-F	3.47 (0.05)	0.03	0.23*	0.48**	0.26**	−0.26**	−0.30**	−0.20*	−0.42**	–

Sample size for all correlations is N = 95, except for those involving the STMO, for which N = 93 because two study participants did not answer a question relative to STMO.
* p < 0.05.
** p ≤ 0.01.

Although correlations between chronotype and specific psychological and behavioral traits (e.g., personality traits, novelty-seeking and risk-taking, or socio-sexuality; see Introduction for references) have been reported before, this is the first study reporting an association between chronotype and a composite measure of life-history (Figueredo et al., 2005), supporting our hypothesis that a life history perspective provides an effective framework for understanding inter-individual variation in chronotype from a functional and evolutionary perspective. Our results were obtained with an all-male population, but previous studies reported differences in the same direction between morning- and evening-types for women as well (e.g., in socio-sexuality: Jankowski et al., 2014; in risk-taking: Maestripieri, 2014).

Our results are consistent with the hypothesis that eveningness may have evolved to facilitate short-term mating (Piffer, 2010), and with previous findings indicating that night owls exhibit psychological, behavioral and even physiological characteristics that may be conducive to promiscuous sexual relationships (e.g., extraversion, narcissism and Machiavellism, impulsivity, novelty-seeking and risk-taking, high arousability and cortisol levels, positive attitudes toward unrestricted socio-sexuality, and tendency to be single or in short-term romantic relationships; Jonason et al., 2013; Maestripieri, 2014; Piffer, 2010; Randler et al., 2012). The life history perspective taken in our study and our results suggest that future research on the functional significance of variation in chronotype should also incorporate measures of growth and sexual maturation, sex and stress hormones, and reproduction and parental investment. In addition, it would be important to investigate the variation in the quality of early life experience in individuals with different chronotype to better understand the extent to which the environment contributes to this aspect of life history variation.

The association between chronotype and socio-sexuality (see Jankowski et al., 2014; Randler et al., 2012) is likely mediated by psychological mechanisms. Personality is probably one of these mechanisms, as personality has been independently linked to both chronotype and socio-sexuality (e.g., Randler et al., 2012). In this study we investigated time perspective (specifically, future orientation) as another potential psychological mechanism mediating the relationship between chronotype and socio-sexuality. We replicated the

association between morningness and future orientation already reported by previous studies (Díaz-Morales et al., 2008; Milfont & Schwarzenthal, 2014; Stolarski et al., 2013). Moreover, our mediation analyses revealed that the future orientation of morning-types was associated with their long-term mating orientation and relatively low sexual experience, while the present orientation of evening-
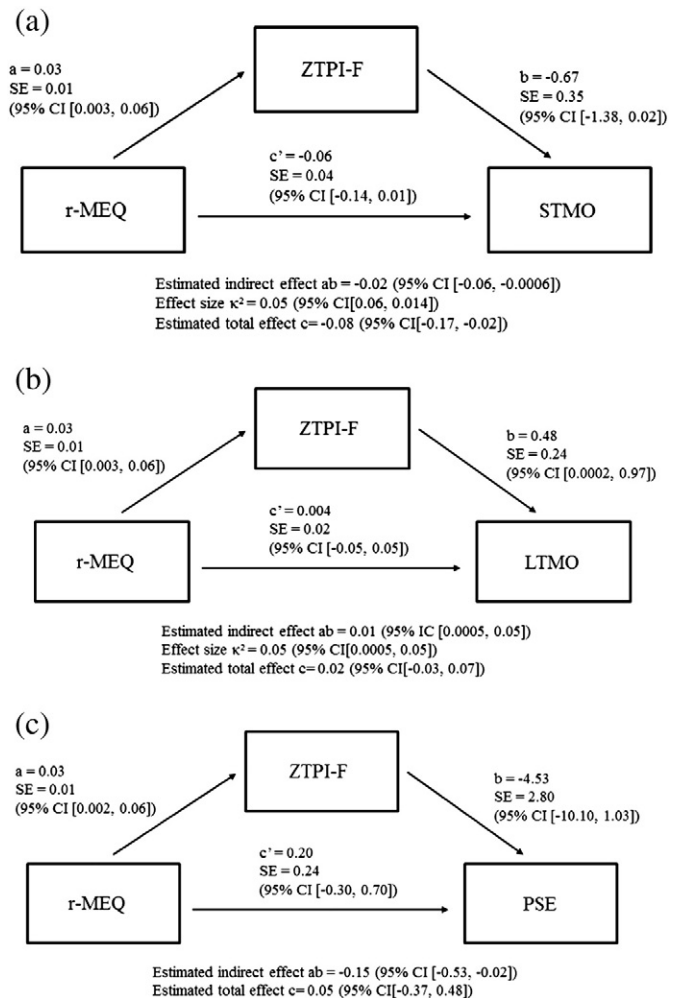

Fig. 1. Simple mediations models for the influence of Zimbardo Future Time Perspective (ZTPI-F) on morningness–eveningness score (r-MEQ) and attitude for short-term mating orientation (STMO) (Fig. 1a), long-term mating orientation (LTMO) (Fig. 1b) and past sexual experience (PSE) (Fig. 1c). Estimated effects of the pathways are based on 95% confidence intervals calculated using bootstrapping. Sample size is N = 95 for the LTMO and PSE analyses and N = 93 for the STMO analysis, because two study participants did not answer a question relative to STMO.

Table 2
Regression analysis for the three sociosexuality variables: short-term mating orientation (STMO), long-term mating orientation (LTMO), and past sexual experience (PSE).

	STMO		LTMO		PSE	
Variable	β	t	B	T	β	t
Age	–	–	–	–	0.36	3.87**
rMEQ	−0.15	−1.49	0.01	0.13	0.10	1.04
ZTPI-F	−0.23	−2.23*	0.25	2.46**	−0.33	−3.50**

Sample size for all analyses is N = 95, except for those involving the STMO, for which N = 93 because two study participants did not answer a question relative to STMO.
* p < 0.05.
** p ≤ 0.01.

types was associated with their short-term mating orientation and greater sexual experience.

It must be acknowledged that our mediation analysis shows that time perspective is a significant statistical mediator between chronotype and sociosexuality but, given the cross-sectional design of our study, does not provide evidence for temporal mediation, i.e. the temporal ordering of chronotype, time perspective, and socio-sexuality. It may be argued that different causal relations than those examined in our mediation analyses may exist between chronotype, time perspective (or personality), and socio-sexuality such that, for example, individuals with a particular time perspective (or personality traits) may be more prone to engage in promiscuous sexual activities, and social or cultural constraints on such activities would lead these individuals to adopt a more nocturnal lifestyle. In this view, chronotype would be the effect rather than the cause of socio-sexuality patterns, and chronotype variation would be better accounted for by socio-cultural norms than by life history theory. We believe, however, that this causal scenario is less plausible than that implied by our mediation analyses and, more generally, by the conceptual framework adopted in this study. This is because individual differences in chronotype are generally stable throughout the life span (Broms et al., 2014; Roenneberg et al., 2007) and determined in large part by genetic inheritance or gene-environment interactions (Hur, 2007; Hur & Lykken, 1998; Koskenvuo, Hublin, Partinen, Heikkila, & Kapiro, 2007). Recent work also points to stable differences in executive function between early birds and night owls, which may explain their differences in time perspective. Specifically, a recent study by Milfont and Schwarzenthal (2014) showed that self-control and ability to delay gratification are the mechanisms responsible for future-orientation in early birds, while deficiencies in these skills might account for the higher propensities for impulsivity and risk-taking exhibited by evening-types (Caci et al., 2005; Killgore, 2007; Maestripieri, 2014). The hypothesis that there are chronotype-related differences in cognitive function is also consistent with evidence for differences in intelligence and in brain structure between early birds and night owls (Piffer, Ponzi, Sapienza, Zingales, & Maestripieri, 2014; Preckel, Lipnevich, Schneider, & Roberts, 2011; Rosenberg, Maximov, Reske, Grinberg, & Shah, 2014). Taken together, these findings suggest that sleep pattern preferences are, in large part, not the result of contingent environmental circumstances or socio-cultural factors but that they are intimately intertwined with specific patterns of neural structure, cognitive function, arousability and emotion, and social and sexual behavior. This view is consistent with our hypothesis that these clusters of traits may represent life history adaptations.

Chronotype has been the subject of hundreds of studies in psychology but rarely, if ever, have the authors of these studies addressed the functional significance or the evolutionary history of inter-individual variation in chronotype. Surprisingly, the study of chronotype has also been neglected by evolutionary psychologists and evolutionary anthropologists. Our study suggests that sleep pattern preferences may be a crucial aspect of human nature and that understanding inter-individual variation in chronotype could significantly enhance our knowledge of the evolution of human life histories and of survival and reproductive strategies. Our study has some important limitations including the use of an all-male subject populations consisting mainly of students at a private university. Furthermore, our sample size was relatively small, and the number of individuals at the two extremes of the chronotype distribution was limited. Further studies are needed to establish whether our findings can be extrapolated to both men and women, in larger subject populations without students and with higher number of unequivocal early birds and night owls.

The life history view of chronotype adopted in our study could be further supported by future studies addressing the possible interactions between genetic predispositions for particular sleep patterns, which may in themselves be adaptive, and the ecological conditions encountered early in life. Further research addressing the cognitive mechanisms underlying the association between chronotype and socio-sexual behavior could make important contributions to both research on circadian rhythms and to research on the cognitive underpinnings of life history and mating strategies.

References

Adan, A., & Almirall, H. (1991). Horne and Östberg morningness-eveningness questionnaire: A reduced scale. *Personality and Individual Differences, 12*, 241–253.

Adan, A., Archer, S. N., Hidalgo, M. P., Di Milia, L., Natale, V., & Randler, C. (2012). Circadian typology: A comprehensive review. *Chronobiology International, 29*, 1153–1175.

Belsky, J., Steinberg, L., & Draper, P. (1991). Childhood experience, interpersonal development, and reproductive strategy: An evolutionary theory of socialization. *Child Development, 62*, 647–670.

Broms, U., Pitkaniemi, J., Backmand, H., Heikkila, K., Koskenvuo, M., Peltonen, M., et al. (2014). Long-term consistency of diurnal-type preferences among men. *Chronobiology International, 31*, 182–188.

Caci, H., Mattei, V., Bayale, F. J., Nadalet, L., Dossios, C., Robert, P., et al. (2005). Impulsivity but not venturesomeness is related to morningness. *Psychiatry Research, 134*, 259–265.

Caci, H., Robert, P., & Boyer, P. (2004). Novelty seekers and impulsive subjects are low in morningness. *European Psychiatry, 19*, 79–84.

Chelminski, I., Petros, T., Plaud, J. J., & Ferraro, F. R. (2000). Psychometric properties of the reduced Horne and Östberg questionnaire. *Personality and Individual Differences, 29*, 469–478.

Chisholm, J. S., Quinlivan, J. A., Petersen, R. W., & Coall, D. A. (2005). Early stress predicts age at menarche and first birth, adult attachment, and expected lifespan. *Human Nature, 16*, 233–265.

DeCoursey, P. J. (2004). The behavioral ecology and evolution of biological timing systems. In J. C. Dunlap, J. J. Loros, & P. J. DeCoursey (Eds.), *Chronobiology: Biological timekeeping* (pp. 27–66). Sinauer Associates, Inc.: Sunderland, MA.

Del Giudice, M. (2009). Sex, attachment, and the development of reproductive strategies. *Behavioral and Brain Sciences, 32*, 1–21.

Del Giudice, M. (2014). An evolutionary life history framework for psychopathology. *Psychological Inquiry, 25*, 261–300.

Del Giudice, M., & Belsky, J. (2011). The development of life history strategies: Toward a multi-stage theory. In D. M. Buss, & P. H. Hawley (Eds.), *The evolution of personality and individual differences* (pp. 154–176). New York: Oxford University Press.

DeYoung, C. G., Hasher, L., Djikic, M., Criger, B., & Peterson, J. B. (2007). Morning people are stable people: Circadian rhythm and the higher-order factors of the big-five. *Personality and Individual Differences, 43*, 267–276.

Di Milia, L., Adan, A., Natale, V., & Randler, C. (2013). Reviewing the psychometric properties of contemporary circadian typology measures. *Chronobiology International, 30*, 1261–1271.

Díaz-Morales, J. F. (2007). Morning and evening-types: Exploring their personality styles. *Personality and Individual Differences, 43*, 769–778.

Díaz-Morales, J. F., Ferrari, J. R., & Cohen, J. R. (2008). Indecision and avoidant procrastination: the role of morningness-eveningness and time perspective in chronic delay lifestyles. *The Journal of General Psychology, 135*, 228–240.

Ellis, B. J. (2004). Timing of pubertal maturation in girls: an integrated life history approach. *Psychological Bulletin, 130*, 920–958.

Figueredo, A. J., Vasquez, G., Brumbach, B. H., Schneider, M. R., Sefcek, J. A., Tal, I. R., et al. (2006). Consilience and life history theory: From genes to brain to reproductive strategy. *Developmental Review, 26*, 243–275.

Figueredo, A. J., Vasquez, G., Brumbach, B. H., Sefcek, J. A., Kirsner, B. R., & Jacobs, W. J. (2005). The K-factor: Individual differences in life history strategies. *Personality and Individual Differences, 39*, 1349–1360.

Hastings Hagenauer, M., & Lee, T. M. (2012). The neuroendocrine control of the circadian system: Adolescent chronotype. *Frontiers in Neuroendocrinology, 33*, 211–229.

Hayes, A. F. (2008). *Introduction to mediation, moderation and conditional process analysis: A regression-based approach.* New York: Guilford Press.

Horne, J. A., & Östberg, O. (1976). A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. *International Journal of Chronobiology, 4*, 97–110.

Horne, J. A., & Östberg, O. (1977). Individual differences in human circadian rhythms. *Biological Psychology, 5*, 179–190.

Hur, Y. M. (2007). Stability of genetic influence on morningness-eveningness: A cross-sectional examination of South Korean twins from preadolescence to young adulthood. *Journal of Sleep Research, 16*, 17–23.

Hur, Y. M., & Lykken, D. T. (1998). Genetic and environmental influence on morningness–eveningness. *Personality and Individual Differences, 25*, 917–925.

Jackson, J. J., & Kirkpatrick, L. A. (2007). The structure and measurement of human mating strategies: Toward a multidimensional model of sociosexuality. *Evolution and Human Behavior, 28*, 382–391.

Jankowski, K. S., Diaz-Morales, J. F., Vollmer, C., & Randler, C. (2014). Morningness-eveningness and sociosexuality: Evening females are less restricted than morning ones. *Personality and Individual Differences, 68*, 13–17.

Jonason, P. K., Jones, A., & Lyons, M. (2013). Creatures of the night: Chronotypes and the dark triad traits. *Personality and Individual Differences, 55*, 538–541.

Kaplan, H. S., & Gangestad, S. W. (2005). Life history theory and evolutionary psychology. In D. M. Buss (Ed.), *Handbook of Evolutionary Psychology* (pp. 68–95). New York: Wiley.

Kerkhof, G. A., & Van Dogen, H. P. A. (1996). Morning-type and evening-type individuals differ in the phase position of their endogenous circadian oscillator. *Neuroscience Letters, 218*, 153–156.

Killgore, W. D. S. (2007). Effects of sleep-deprivation and morningness-eveningness traits on risk-taking. *Psychological Reports, 100*, 613–626.

Klei, L., Reitz, P., Miller, M., Wood, J., Maendel, S., Gross, D., et al. (2005). Heritability of morningness-eveningness and self-report sleep measures in a family-based sample of 521 Hutterites. *Chronobiology International, 22*, 1041–1054.

Koskenvuo, M., Hublin, C., Partinen, M., Heikkila, K., & Kapiro, J. (2007). Heritability of diurnal type: A nationwide study of 8753 adult twin pairs. *Journal of Sleep Research, 16*, 156–162.

Kruger, D. J., Reischl, T., & Zimmerman, M. A. (2008). Time perspective as a mechanism for functional developmental adaptation. *Journal of Social, Evolutionary, and Cultural Psychology, 2*, 1–22.

Maestripieri, D. (2014). Night owl women are similar to men in their relationship orientation, risk-taking propensities, and cortisol levels: Implications for the adaptive significance and evolution of eveningness. *Evolutionary Psychology, 12*, 130–147.

Matthews, G. (1988). Morningness-eveningness as a dimension of personality: Trait, state and psychophysiological correlates. *European Journal of Personality, 2*, 277–293.

Milfont, T. L., & Schwarzenthal, M. (2014). Explaining why larks are future-oriented and owls are present-oriented: Self-control mediates the chronotype-time perspective relationship. *Chronobiology International, 31*, 581–588.

Muro, A., Gomá-i-Freixanet, M., & Adan, A. (2012). Circadian typology and sensation-seeking in adolescents. *Chronobiology International, 29*, 1376–1382.

Nowack, K., Milfont, T. L., & van der Meer, E. (2013). Future versus present: Time perspective and pupillary response in a relatedness judgment task investigating temporal event knowledge. *International Journal of Psychophysiology, 87*, 173–182.

Piffer, D. (2010). Sleep patterns and sexual selection: An evolutionary approach. *Mankind Quarterly, 50*, 361–375.

Piffer, D., Gunawardane, K. G. C., & Custance, D. M. (2011). Evidence of sexual selection for evening orientation in human males: A cross-cultural study in Italy and Sri Lanka. *Interdisciplinary Bio Central Journal, 3*, 1–8.

Piffer, D., Ponzi, D., Sapienza, P., Zingales, L., & Maestripieri, D. (2014). Morningness-eveningness and intelligence among high-achieving US students: Night owls have higher GMAT scores than early morning types in a top-ranked MBA program. *Intelligence, 47*, 107–112.

Preacher, K. J., & Kelley, K. (2011). Effect size measures for mediation models: Quantitative strategies for communicating indirect effects. *Psychological Methods, 16*, 93–115.

Preckel, F., Lipnevich, A. A., Schneider, S., & Roberts, R. D. (2011). Chronotype, cognitive abilities, and academic achievement: A meta-analytic investigation. *Learning and Individual Differences, 21*, 483–492.

Randler, C. (2007). Gender differences in morningness–eveningness assessed by self-report questionnaires: A meta-analysis. *Personality and Individual Differences, 43*, 1667–1675.

Randler, C., & Bausback, V. (2010). Morningness–eveningness in women around the transition through menopause and its relationship with climacteric complaints. *Biological Rhythm Research, 41*, 415–431.

Randler, C., Ebenhöh, N., Fischer, A., Höchel, S., Schroff, C., Stoll, J. C., et al. (2012). Eveningness is related to men's mating success. *Personality and Individual Differences, 53*, 263–267.

Roenneberg, T., Kuehlne, T., Juda, M., Kantermann, T., Allebrandt, K., Gordijn, M., et al. (2007). Epidemiology of the human circadian clock. *Sleep Medicine Reviews, 11*, 429–438.

Roenneberg, T., Kuehnle, T., Pramstaller, P. P., Ricken, J., Havel, M., Guth, A., et al. (2004). A marker for the end of adolescence. *Current Biology, 14*, 1038–1039.

Rosenberg, J., Maximov, I. I., Reske, M., Grinberg, F., & Shah, N. J. (2014). "Early to bed, early to rise": Diffusor tensor imaging identifies chronotype-specificity. *NeuroImage, 84*, 428–434.

Simons, J., Vansteenkiste, M., Lens, W., & Lacante, M. (2004). Placing motivation and future time perspective theory in a temporal perspective. *Educational Psychology Review, 16*, 121–139.

Stolarski, M., Ledzinska, M., & Matthews, G. (2013). Morning is tomorrow, evening is today: Relationships between chronotype and time perspective. *Biological Rhythm Research, 44*, 181–196.

Tonetti, L, Adan, A., Caci, H., De Pascalis, V., Fabbri, M., & Natale, V. (2010). Morningness-eveningness preference and sensation seeking. *European Psychiatry, 25*, 111–115.

Tsaousis, I. (2010). Circadian preferences and personality traits: A meta-analysis. *European Journal of Personality, 24*, 356–373.

Zimbardo, P. G., & Boyd, J. N. (1999). Putting time in perspective: A valid, reliable individual-differences metric. *Journal of Personality and Social Psychology, 77*, 1271–1288.