Evolutionary Psychology
July-September 2019: 1–10
© The Author(s) 2019
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/1474704919859760
journals.sagepub.com/home/evp
SAGE

Reproductive Success, Relationship Orientation, and Sexual Behavior in Heterosexuals: Relationship With Chronotype, Sleep, and Sex

Ali Kasaeian[1], Corina Weidenauer[1], Martin Hautzinger[2], and Christoph Randler[1]

Abstract

Following previous studies, chronotype was related to sexual attitudes and behavior. Evening people tend to be more promiscuous and follow short-term mating strategies and extra-pair matings (EPM), which might lead to a higher reproductive success. In this study, one aim was to assess reproductive success directly by asking for children, and, second, to obtain a higher sample size for the analysis of sexual behavior and chronotype than in previous studies. $N = 1{,}843$ heterosexual persons (551 men, 1,288 women, 4 without data) responded to our online survey. Five hundred fifty-nine persons were single and 1,281 in a relationship; 203 reported having children (1.9 ± 0.81). Age was positively related and age at first intercourse was negatively related to the number of children. People being later chronotypes had fewer children, and shorter sleep duration was linked with more children. Extroversion was correlated with number of children, as was the long-term relationship orientation. Sociosexual orientation and EPM were unrelated to number of children. Age at first intercourse was earlier in evening people, and unrestricted sociosexuality was higher in late chronotypes. Morning orientation correlated with long-term relationship orientation and eveningness with short-term relationship orientation. Number of sexual partners was lower in morning people. Men were more evening oriented, later chronotypes, and slept shorter. There were no differences in sociosexual behavior, but men were less restricted in attitude and desire. Men scored higher on short-term relationship orientation and women higher on long-term relationship orientation. This study confirmed previous results about chronotype and sexual behavior but provided the first evidence that morningness was related to higher reproductive success.

Keywords

chronotype, extroversion, morningness–eveningness, relationship orientation, sociosexuality

Date received: December 4, 2018; Accepted: June 2, 2019

Nonhuman animal studies showed that aspects of sleep behavior are related to reproductive success. For example, in the pectoral sandpiper (*Calidris melanotos*), a polygynous shorebird, males that sleep less during the breeding season have more matings and a higher reproductive success because the males spent more time in sexual activities (Lesku et al., 2012). The pectoral sandpiper inhabits the Arctic tundra, and therefore the daylight period is equal to 24 h, and there is no nighttime which enforces sleep. Concerning a small, common hole-nesting European songbird, the blue tit (*Cyanistes caeruleus*), Poesel, Kunc, Foerster, Johnsen, and Kempenaers (2006) reported that males that got up earlier produced more extra-pair offspring because they started singing at dawn earlier. This was related to their individual condition, thus an honest signal of quality. These studies show that both sleep

[1] Department of Biology, Eberhard Karls University of Tübingen, Tübingen, Germany
[2] Department of Psychology, Eberhard Karls University of Tübingen, Tübingen, Germany

Corresponding Author:
Christoph Randler, Department of Biology, Eberhard Karls University of Tübingen, Auf der Morgenstelle 24, Tübingen D-72076, Germany.
Email: christoph.randler@uni-tuebingen.de

Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (http://www.creativecommons.org/licenses/by-nc/4.0/) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (https://us.sagepub.com/en-us/nam/open-access-at-sage).

duration and sleep timing may have an influence on animal reproduction (Randler, 2014).

Previous studies in humans were inspired by these animal studies and revealed the relationship between circadian preference or chronotype and sexual behavior (Jankowski, Díaz-Morales, Vollmer, & Randler, 2014; Matchock, 2018; Piffer, 2010; Randler et al., 2012; Randler, Jankowski, Rahafar, & Díaz-Morales, 2016). This was theoretically grounded on the sexual dimorphism of men and women, in fact following Darwin's theory of sexual selection (Bateman, 1948). Men go to bed later, get up later, and usually are more evening oriented (see meta-analysis of Randler, 2007; Randler & Engelke, 2019). These meta-analyses were based usually on one-dimensional conceptualizations of morningness–eveningness (M/E), but for two- or three-dimensional questionnaires, only the evening component might be important for the discussed mating benefits (see, for instance, Putilov, 2014). Thus, Piffer (2010) concluded that this could be a sexually selected trait, and he hypothesized that evening men should have a higher mating success. This has been replicated in other studies (Gunawardane, Piffer, & Custance, 2011; Randler et al., 2012). In all these studies, mating success was operationalized by questions about lifetime sexual partners and number of extra-pair matings (EPM), following Gangestad and Thornhill (1997). Following these studies, Randler, Jankowski, Rahafar, & Díaz-Morales (2016) investigated this relationship by using the Sociosexual Inventory–Revised (SOI-R; Penke & Asendorpf, 2008). In this study, the SOI-R scores were analyzed. Evening orientation and short sleep duration were correlated with a higher overall score in sociosexuality, as well as the three subscales of Behavior, Attitudes, and Desire. The strongest effect on sociosexuality was caused by sex, followed by age. Higher age was associated with less limited sociosexuality, and men were less restricted than women (Randler et al., 2016).

Hunter-gatherer societies are considered to be closer to our evolutionary ancestors than humans in industrialized countries. Therefore, assessing sleep and chronotype in these societies may give a useful hint for sleep in our evolutionary past. Different chronotypes are already present, for example, in Hadza hunter-gatherers of Tanzania (Samson, Crittenden, Mabulla, Mabulla, & Nunn, 2017). Similarly, sleep duration also was comparable between hunter-gatherer societies and northern cultures (Yetish et al., 2015). Yetish et al. (2015) analyzed two societies in Africa (Namibia and Tanzania) and one in South America (Bolivia). Average sleep onset across groups occurred on average 3.3 hr after sunset (Yetish et al. 2015). This suggests that traditional hunter–gatherer societies tend to sleep as long as industrialized societies. Yetish, Kaplan, and Gurven (2018) further investigated sleep patterns in a subsistence society, the Tsimané hunter-horticulturalists in lowland Bolivia. Nightly variation in sleep duration was driven by highly variable sleep onset, especially for men (Yetish, Kaplan, & Gurven, 2018).

Concerning sexual activities in modern societies, sexual activities also take place mostly during the nights (Jankowski, Díaz-Morales, Vollmer, & Randler, 2014), and most sexual encounters among partners occur around bedtime (11 p.m. to 1 a.m.; Refinetti, 2005). Concerning chronotypes, evening types reported higher desire/activity in the later hours compared to morning types (Jankowski et al., 2014). Hewlett and Hewlett (2010) reported nighttime sexual activities in the Aka and Ngandu people in Africa, with about two and three sexual encounters per night, followed by some days of abstinence. Thus, sleep variables and sexual activities do not seem to differ between Western/Northern societies and hunter-gatherers.

Both evening orientation and shorter sleep duration may have been of advantage in ancient societies because the marketplace was in the evening, usually around the camp fire. Fire plays a key role because it extends daylight and leaves time for social activities away from subsistence work (Wiessner, 2014). An analysis of talks around the bushfire at night in !Kung bushmen of Southern Africa showed that fire talks have an immense potential night activities steer away from tensions of the day to singing, dancing, religious ceremonies, and enthralling stories (Wiessner, 2014). Skilled storytellers, in turn, are preferred social partners and have a higher reproductive success (Smith et al., 2017). As evening people are more extroverted, talkative, and humorous (Adan et al., 2012), these personality traits may be beneficial in telling stories in front of groups and, therefore, also may play a key role in attracting mates. In line with this, Putilov (2014) hypothesized that, because of a sexual division of daytime labor in ancestral societies, eveningness (EV) might have evolved to create an early night lek for courtship.

Ancient humans may have had courtship marriages, with three of four African hunter-gatherers having courtship marriages (Walker, Hill, Flinn, & Ellsworth, 2011). Therefore, courtship activities were important and should have taken place at night. One example stems from Piffer (2010), who suggests that the most likely way in which sexual selection could have acted on human sleep patterns is through a lek display system, which took place at night when people were free from foraging activities or other tasks and stayed closer to each other in order to defend themselves from predators. For example, among the Wodaabe of Niger, men prepare their clothing and their makeup. They then line up and chant and step forward opening their eyes really wide and grimacing to show their pretty teeth to the crowd of women before them. They dance vigorously for seven full nights, and at the end of the ceremony, each woman chooses the man that she finds most attractive and invites him for a sexual encounter (Miller, 2011).

Further studies especially looked at the behavior of women, to shed light on the question whether this might be a sexually selected trait or a basic individual difference trait linked with EV orientation in both sexes. Jankowski et al. (2014) found that Polish women were in general more limited in all facets of sociosexuality than men, confirming many previous results that showed higher unrestricted sociosexuality in men. Evening-oriented women showed less limited global sociosexuality, as well as less restricted sociosexual behavior, attitude, and desire. Therefore, EV can be seen as a general factor being related with sociosexuality irrespective of sex. Similar results have been obtained by Maestripieri (2014). Both female and male evening owls were single rather than in long-term

relationships. Female night owls had average cortisol profiles and risk tendencies more similar to those of men than those of morning-type women (Maestripieri, 2014). This suggests that evening orientation is associated with psychological and behavioral traits that are crucial for short-term mating strategies. Díaz-Morales et al. (2018) conducted a cross-cultural study and surveyed 1,483 women from Poland, Spain, Germany, and Slovakia. Women with late sleep timing are less restricted in their sexual encounters.

In the following, we present the theoretical background to all aspects that are considered in this current study.

Theoretical Background

Extroversion

Extroversion is a personality trait from the Big Five conceptualization of personality (McCrae & Costa, 1999). Extroversion has been found to be an influential predictor for acquiring mates (Nettle, 2005). This means that people who are more open toward others, establish new contacts easily, are talkative and prefer to be in the center of conversations and have more lifetime partners and sexual contacts (replicated, e.g., by Randler et al., 2012). Therefore, we hypothesize that extroverted people should have more sexual contacts and more children (as found by Berg, Lummaa, Lahdenperä, Rotkirch, & Jokela, 2014). In addition, extroversion is related to M/E (Randler, Schredl, & Göritz, 2017); therefore, we included this personality dimension into the analysis of reproductive success and circadian preference.

Morningness–Eveningness/Chronotype

M/E is concerned with the preferred times of the day for intellectual and physical activity. Morning people get up and go to bed early, while evening people prefer to get up late and go to bed late. Thus, this variable is different from sleep duration or sleep length because it is related to the timing of sleeping (see Adan et al., 2012 for an overview). In addition, M/E also includes some measures of affect, for example, the feeling in the morning and in the evening. Previously, M/E was considered a one-dimensional construct, but recent research showed that morningness and EV are separate yet related constructs (Preckel et al., 2013; Putilov, Donskaya, & Verevkin, 2015; Randler et al., 2016). Some studies already reported a higher mating success, as measured in lifetime partners and sexual contacts, and EPM in evening men (Gunawardane et al., 2011; Piffer, 2010; Randler et al., 2012; Randler et al., 2016). In addition, other variables related to sleep such as sleep duration, may also contribute to this relationship and are also considered in this study. We hypothesize that shorter sleep duration and later sleep timing should end up in more children and a higher "mating success," that is, lifetime partners, extra-pair copulations, and more sociosexual unrestricted behavior.

Sociosexuality

Sociosexuality is defined as individual differences in willingness to engage in uncommitted sexual relations (Penke & Asendorpf, 2008; Simpson & Gangestad, 1991). People with unrestricted sociosexual orientation report more casual sex encounters and multiple and concurrent sexual partners (Seal & Agostinelli, 1994). The SOI-R has good cross-cultural validity and has been used in many different countries (Schmitt, 2005). Sociosexuality contains three aspects: behavior, attitude, and desire; thus, a number of sexual partners in a life span reflect only the behavioral aspect of sociosexual orientation (Jankowski, Díaz-Morales, Vollmer, & Randler, 2014; Penke & Asendorpf, 2008). The personality profile of sociosexually unrestricted people and the personality profile of evening types have some characteristics in common, such as greater impulsivity and risk-taking (Seal & Agostinelli, 1994), openness to experience (Lameiras Fernández & Rodríguez Castro, 2003), higher extroversion, and lower agreeableness and conscientiousness (Hofer et al., 2010). We hypothesize that sociosexually less impaired people should show a higher EV, shorter sleep duration, and later sleep timing. Also, sociosexually unrestricted people might have more children by chance.

Long-Term and Short-Term Relationship Orientation

In addition to the SOI-R, we applied the Relationship Orientation Questionnaire (ROQ) that also measures some kind of sociosexuality but is based on another conceptualization, namely that short-term and long-term orientation are not two ends of a continuum but rather two independent scales (Schwarz, Mustafić, Hassebrauck, & Jörg, 2011). Especially, long-term relationship orientation should be related to having children, in both sexes (Stewart, Stinnett, & Rosenfeld, 2000). We hypothesize that long-term relationship orientation should result in a higher number of children; in addition, as evening people tend to be more sociosexually unrestricted, we hypothesize that EV should be related to short-term relationship orientation, while morningness should be associated with a long-term relationship orientation.

Rationale

Although the studies cited above give many incidences for the hypothesis that evening people should have a higher reproductive success, none of these studies used a direct measure of fitness. All studies are based on mating, number of partners, or sociosexual behavior. In this study, we examine sexual-related behavior in the context of M/E, but we also asked—for the first time—for reproductive success, which we operationalized as the number of children. This is, from a biological viewpoint, the best measure of fitness or reproductive success. In addition, we control for probable confounding factors such as extroversion or propensity of going out, which have been identified in previous studies as being related to sexual

behavior, morningness, or reproductive success. We have two mutual exclusive hypotheses. One is to expect a higher number of children in evening-oriented persons because of a higher number of lifetime partners, less sociosexual restrictions, and more EPM. The other way around would be to expect more children in morning-oriented persons because they follow a long-term relationship orientation, which would lead to childbirth in a society with a high usage of contraceptives.

Material and Methods

Participants and Data Collection

Students and employees of the Eberhard Karls University of Tübingen were contacted by a circular mail released on October 23, 2017. They were informed that it is a short questionnaire study about chronotype and partnership and will last about 15 min. The data were used in an anonymized procedure only for research purposes. We explicitly stated that participation is voluntary and unpaid and that participants do not have to complete the questionnaire but can stop, withdraw, and leave at any time without any consequences. The interested participants could then click on a link provided to the survey in an online portal (SoSciSurvey). Formal consent was not asked for but was assumed when participants clicked on the link "start the survey" and started answering. Having completed the full questionnaire was considered as consent. The questionnaire took 10.74 $\pm$ 4.0 (*SD*) min to complete. From the initial participants who clicked on the first page ($N = 3{,}498$), a total of 2,098 completed the questionnaire. From these, the heterosexual persons were $N = 1{,}843$ (551 men [29.9%], 1,288 women, 4 without data). Five hundred fifty-nine persons reported to be single and 1,281 were in a relationship (3 without answer); 203 reported that they have children (69 men, 134 women, 1.9 $\pm$ 0.81, range 1–5). Further descriptive statistics are reported in Table 1.

Table 1. Descriptive Statistics of the Sample.

Variables in the study	*N*	Mean	*SD*
Age	1,843	25.62	7.69
Age at first intercourse	1,678	17.72	2.74
Morning affect (MESSi)	1,840	3.13	0.84
Eveningness (MESSi)	1,840	3.15	0.82
Distinctness/amplitude (MESSi)	1,840	3.40	0.66
Extroversion	1,840	3.26	0.57
Sociosexual orientation: desire	1,840	2.43	1.03
Sociosexual orientation: behavior	1,840	2.05	0.89
Sociosexual orientation: attitude	1,840	3.11	1.24
Long-term relationship orientation	1,840	6.02	0.96
Short-term relationship orientation	1,840	2.55	1.30
How often do you have sex? (1 = *daily*, 6 = *never*)	1,840	3.50	1.50
Propensity of going out	1,840	3.53	0.75
Number of sex partners (coded)	1,833	3.57	1.68
Sleep duration (week)	1,812	08:02	1:04
Sleep duration (weekend)	1,818	08:43	1:09
Sleep duration (average)	1,803	08:14	0:56
Midpoint of sleep (week)	1,812	03:24	0:55
Midpoint of sleep (weekend)	1,818	05:01	1:14
Corrected midpoint of sleep	1,803	04:46	1:17

Note. MESSi = M/E Stability Scale–improved.

Measurements

Demographic Data

Age, sex, sexual orientation, number of children, age at first intercourse, and the total number of sexual partners were asked for in the demographic data.

M/E and Chronotype

The M/E Stability Scale–improved (MESSi; Díaz-Morales, Randler, Arrona-Palacios, & Adan, 2017; Randler, Díaz-Morales, Rahafar & Vollmer, 2016) contains three subscales. The Morning Affect (MA) subscale measures the affective facet of the M/E trait, which is considered as the relative freshness and energy after waking up (e.g., How alert do you feel during the first half hour after having awakened in the morning? In general, how is your energy level in the morning?). Higher scores represent higher morning orientation. The Eveningness (EV) subscale mainly contains feeling (affect) and energy in the evening as well as studying and learning during evening hours (e.g., I feel I can think the best in the evening; in general, how is your energy level in the evening?). Higher scores indicate higher EV. Third, distinctness (DI) measures the subjective amplitude or the range of diurnal variation, which is the awareness of the difference between hyper- and hypo-activation phases, the ability to volitionally modulate one's own psychophysiological state and feeling the variation of daily changes (I can focus at any time of the day; there are moments during the day where I feel unable to do anything). Higher scores show higher fluctuations. Each subscale is composed of 5 items with a Likert response format coded from 1 to 5. MESSi's factorial structure and reliability (Díaz-Morales & Randler, 2017; Randler et al., 2016; Rodrigues et al., 2018; Tomazic & Randler, 2018) and its transcultural validity (factorial invariance) in Iran, Germany, and Spain (Rahafar, Randler, Díaz-Morales, Kasaeian, & Heidari, 2017) have been corroborated in four previous studies. The Cronbach's α of the scales in the current study was .872 for MA, .846 for EV, and .751 for DI.

Sleep Duration

The MESSi does not contain any clock times, which was an improvement to previous scales (see discussion in Randler, Díaz-Morales, Rahafar, & Vollmer, 2016) to separate it from the mainly clock time–based measures such as the Munich Chrono Type Questionnaire (MCTQ; Roenneberg, Wirz-Justice, & Merrow, 2003). We therefore used the clock-based measures in addition to our M/E measure. We asked for bedtimes and risetimes on weekdays and weekends. These variables can be used to assess sleep duration on weekdays and weekends, as well as average sleep duration (which is 5 times

weekday sleep and 2 times weekend sleep, divided by 7). Also, midpoint of sleep can be calculated, which is the midpoint of time between sleep onset and waking up. Furthermore, we used the correction algorithm presented in Roenneberg et al. (2004) to measure a corrected midpoint of sleep on weekend days because people usually tend to sleep longer on weekends as a kind of compensation for the sleep debt accumulated during the week. Later clock times represent later chronotypes.

Extroversion

We used the Extraversion Scale from the NEO Five-Factor Inventory (NEO-FFI, original version by Costa & McCrae, 1992) in its German version by Borkenau and Ostendorf (1993). Extroverted persons are characterized as sociable, talkative, and do like encouragements (e.g., "I really like to talk to other people."). High values represent higher extroversion. This dimension is assessed with 12 items, realized in a 5-point Likert-type format, and 4 items of each dimension are recoded. Cronbach's α in the present sample was .785.

Propensity of Going Out

We used these parts of the Sexual Behavior Questionnaire (SBQ) of Piffer (2010) and Gunawardane et al. (2011) that are related to propensity of going out. "How often do you go out after sunset?" (from 1 = *daily* to 6 = *never*), "At what time do you go out?" (from 1 = *6:00 p.m.* to 6 = *after 11:00 p.m.*), "How many hours do you stay out?", coded from 1 (*1 h*) to 6 (*6 h*). ''When do you come back home?'' coded from 1 (*about 9:00 p.m.*) to 6 (*after 1:00 a.m.*). "Would you prefer going to a party or to look at television/video/DVD at home?", coded 1 (*party*), 2 (*usually party*), 3 (*undecided*), 4 (*usually watching TV*), and 5 (*stay at home watching TV/video*). The Cronbach's α coefficient of the scale was .66.

SOI-R

The SOI-R was used in this study (Penke, 2011; Penke & Asendorpf, 2008). The coding was based on a 1–5 Likert-type scale. The scale consists of 9 items, with 3 items per dimension, Behavior (mean: 2.76, *SD*: 1.83), Attitude (mean: 6.42, *SD*: 2.33), and Desire (mean: 5.62, *SD*: 1.91). The scale is reliable and valid in its German version (Penke & Asendorpf, 2008), and the Cronbach's α level was .851 for SOI Desire, .780 for Behavior, and .854 for Attitude.

ROQ

We used the German version of the ROQ (Schwarz & Hassebrauck, 2007). The ROQ contains two scales, each measured with 7 items, based on a 1–7 Likert-type scale. One scale is concerned with long-term relationship orientation (Cronbach's $\alpha = .825$), and the other one with short-term relationship orientation (Cronbach's $\alpha = .874$).

Sexual Partners and EPM

We asked for lifetime number of sexual partners coded from 1 to 9 (1 = *0*, 2 = *1*, 3 = *2–3*, 4 = *4–5*, 5 = *6–10*, 6 = *11–15*, 7 = *16–20*, 8 = *21–30*, 9 = *more than 30*). To assess EPM, we used questions from Gangestad and Thornhill (1997): (1) Whether they had ever had sex with a person of the opposite sex other than a relationship partner during a romantic relationship (from 0 [*never*] to 9 [*>30 times*]) and, if so, with how many persons. (2) Whether they had ever had sex with a person of the opposite sex they knew was involved romantically with another person at that time (from 0 [*never*] to 9 [*>30 times*] and the exact number of partners) and, if so, with how many such persons. We forced these variables into one factor by a factor analysis principal component analysis (PCA) and saved the residuals for further calculations.

Further, age at first intercourse or virginity loss was asked for. In addition, we asked "How often do you have sex?" coded 1–6 (1 = *almost daily*, 6 = *never*).

Statistical Analysis

We used SPSS 25.0 for the statistical analysis. For the predictor number of children, we applied a multiple linear regression (full model). Additionally, Pearson's correlations to analyze bivariate relationships and *t* test for comparisons were used. Effect sizes were presented as Hedge's *d* calculated with Meta-Win (Version 2).

Results

Predictors of the Number of Children

The regression analysis was based on a full model with all predictors being entered simultaneously, $F(18, 1{,}602) = 82.160$, $p < .001$, corrected $R^2 = .474$. Regression analysis showed that age was positively related to the number of children (Table 2). Age at first intercourse, in turn, was negatively related to the number of children, suggesting that earlier loss of virginity predicts more children. Midpoint of sleep and sleep duration contributed to the regression model with people being later chronotypes having fewer children, and shorter sleep duration was linked with more children. Extroversion was positively correlated with number of children, as was the long-term relationship orientation. Propensity of going out and lifetime number of sexual partners were negatively correlated. Thus, people with more children are going out less, and people with many sexual partners have fewer children.

Chronotype, Sleep, and Sexual Behavior

In the next step, we analyzed the associations between chronotype, circadian preference, sleep duration, and sexual behavior. The number of children was higher in morning-oriented persons and lower in EV people and late chronotypes. Age at first intercourse was earlier in evening people, and the scores on the SOI-R were also higher in late chronotypes, showing a

Table 2. Statistical Predictors of the Number of Children. Multiple regression with simultaneously entering variables.

Predictors	β	*t*	*p*
Constant		0.507	.612
Age	.683	29.913	**<.001**
Sex	.003	0.143	.887
Age at first intercourse	−.092	−4.493	**<.001**
Morning Affect (MESSi)	−.015	−.645	.519
Eveningness (MESSi)	−.029	−1.255	.210
Distinctness/amplitude (MESSi)	.009	0.470	.638
Corrected midpoint of sleep	−.072	−3.079	**.002**
Sleep duration (average)	−.041	−2.141	**.032**
Extroversion	.052	2.649	**.008**
Sociosexual orientation: desire	−.009	−0.350	.727
Sociosexual orientation: behavior	.017	0.586	.558
Sociosexual orientation: attitude	−.019	−0.668	.504
Long-term relationship orientation	.114	5.730	**<.001**
Short-term relationship orientation	.042	1.332	.183
How often do you have sex? (1 = *daily*, 6 = *never*)	−.025	−1.297	.195
Propensity of going out	−.051	−2.323	**.020**
Number of sex partners (coded)	−.150	−5.086	**<.001**
Extra-pair matings	−.003	−0.135	.893

Note. MESSi = M/E Stability Scale–improved. Significant results with $p < .05$ are printed in bold.

less restricted sociosexuality in evening people. Morningness correlated with long-term relationship orientation and EV with short-term relationship orientation. The number of sexual partners was lower in morning people and higher in evening ones (Table 3).

Sex Differences

Sex differences were found in some traits (Table 4). Men were slightly older. Age at first intercourse was 18.31 years in men and 17.48 years in women. Men were more evening oriented, later chronotypes, and slept shorter. There were no differences in SOI-R Behavior, but men were less restricted in Attitude and Desire. Men scored higher on short-term relationship orientation and women higher on long-term relationship orientation. There was no significant difference in number of sexual partners between men and women ($p = .06$). Men reported to have more sex than women.

Discussion

This study showed that morning-oriented persons have more children, while evening-oriented persons have more unrestricted sociosexuality and a more short-term mating strategy. These findings are new and interesting, as they are a bit contradictory. As EV was related to behavior that would increase fitness (more EPM, more lifetime partners, more short-term relationship orientation, less sociosexual restricted behavior), this would lead to a higher fitness at least in a society without contraception. We could not confirm this hypothesis. However, we were able to confirm that morningness is related to a

Table 3. Correlations Between Sexual Behavior, Morningness–Eveningness, and Sleep Variables.

Relationship Between Sleep and Sexual Behavior		MA	EV	DI	MS	Sleep Duration
Age	*r*	.045	−.072**	−.104**	−.267**	−.164**
	p	.054	.002	<.001	<.001	<.001
Number of children	*r*	.067**	−.111**	−.075**	−.296**	−.138**
	p	.004	<.001	.001	<.001	<.001
Age at first intercourse	*r*	.022	−.054*	−.065**	−.138**	−.004
	p	.370	.026	.008	<.001	.858
Extroversion	*r*	.225**	−.061**	−.156**	−.002	.020
	p	<.001	.009	<.001	.922	.389
Sociosexual Orientation: desire	*r*	−.098**	.188**	.016	.217**	−.078**
	p	<.001	<.001	.488	<.001	.001
Sociosexual Orientation: behavior	*r*	−.063**	.067**	.039	.191**	−.038
	p	.007	.004	.090	<.001	.103
Sociosexual Orientation: attitude	*r*	−.053*	.095**	−.003	.219**	−.050*
	p	.023	<.001	.897	<.001	.034
Long-term relationship orientation	*r*	.062**	−.096**	.051*	−.124**	.081**
	p	.008	<.001	.030	<.001	.001
Short-term relationship orientation	*r*	−.073**	.134**	−.014	.244**	−.030
	p	.002	<.001	.556	<.001	.204
Propensity of going out	*r*	−.115**	.166**	−.010	.440**	−.026
	p	<.001	<.001	.684	<.001	.264
Number of sex partners (coded)	*r*	−.059*	.033	.038	.104**	−.041
	p	.011	.155	.103	<.001	.079
Extra-pair matings	*r*	−.004	.031	−.010	−.006	−.044
	p	.856	.181	.678	.785	.061

Note. MA = morning affect; EV = eveningness; DI = distinctness/amplitude; MS = midpoint of sleep.
*$p < .05$. **$p < .01$.

Table 4. Differences Between Men and Women in Sleep, Circadian Preference, and Sexual Behavior.

Variables	Male		Female		*t* Test			
	Mean	*SD*	Mean	*SD*	*t*	*df*	*p*	Hedge's *d*
Age	26.53	8.37	25.18	7.27	3.486	1,837	.001	−0.177
Age at first intercourse	18.31	3.19	17.48	2.49	5.696	1,672	<.001	−0.305
Morning affect (MESSi)	3.14	0.83	3.11	0.85	0.659	1,834	.510	−0.035
Eveningness (MESSi)	3.33	0.74	3.07	0.84	6.479	1,834	<.001	−0.320
Distinctness/amplitude (MESSi)	3.18	0.68	3.50	0.63	−9.651	1,834	<.001	0.495
Corrected midpoint of sleep	29:02	01:24	28:40	01:13	5.663	1,797	<.001	−0.287
Sleep duration (average)	08:02	00:54	08:19	00:55	−6.127	1,797	<.001	0.310
Extroversion	3.16	0.57	3.30	0.57	−4.711	1,834	<.001	0.245
Sociosexual orientation: desire	3.13	1.06	2.13	0.85	21.259	1,834	<.001	−1.089
Sociosexual orientation: behavior	2.08	0.95	2.04	0.87	0.850	1,834	.396	−0.044
Sociosexual orientation: attitude	3.47	1.21	2.96	1.23	8.112	1,834	<.001	−0.416
Long-term relationship orientation	5.71	1.05	6.16	0.88	−9.487	1,834	<.001	0.481
Short-term relationship orientation	3.21	1.48	2.27	1.12	14.979	1,834	<.001	−0.758
How often do you have sex? (1 = *daily*, 6 = *never*)	3.33	1.60	3.57	1.46	−3.194	1,834	.001	0.159
Propensity of going out	3.55	0.81	3.52	0.72	0.637	1,834	.524	−0.040
Number of sex partners (coded)	3.46	1.74	3.62	1.65	−1.88	1,827	.060	0.095
Extra-pair matings	0.08	1.16	−0.03	0.92	2.274	1,815	.023	−0.115

Note. Hedge's *d* is given as a measure of effect size. MESSi = M/E Stability Scale–improved.

higher number of children, probably because it is—at least in Germany—a rather cognitive-based decision. Therefore, people with a long-term relationship orientation, a more sociosexual restricted behavior (higher fidelity), and less EPM might partner or marry and decide to produce children. However, this is a correlative study, which does not allow to securely define the directions of the effects. For example, children may also impact on the sleep behavior and chronotype (Leonhard & Randler, 2009). Therefore, the fact of having children may change the sleep–wake cycle with people becoming earlier chronotypes when having young children. However, this might be only possible to be addressed in a longitudinal prospective study where chronotype is assessed, for example, at the age of 20 years and the people are followed up for at least 20 years.

In line with previous work, evening-oriented people and short sleepers had a higher unrestricted sociosexual behavior, more short-term than long-term relationship orientation, and an earlier loss of virginity (see, e.g., Gunawardane et al., 2011; Piffer, 2010; Randler et al., 2012; Randler et al., 2016). This was the case in both men and women (Díaz-Morales et al., 2017; Jankowski et al., 2014; Maestripieri, 2014). So, this present study replicates some previous findings based on a high sample size. From the viewpoint of the number of partners, EPM, and sociosexual orientation, we were able to confirm that EV was related to sociosexual behavior in both sexes.

We found that number of children was related to MA, EV, and DI from the MESSi, as well as to chronotype and sleep duration based on the calculations obtained from the clock times. This was significant in the bivariate correlations, while midpoint of sleep (chronotype) remained in the regression analysis. One may discuss that midsleep time be rather a state than trait measures (as in the MESSi is), but usually both questionnaire scores are correlated with $r = .5$–$.7$ (e.g., Di Milia, Adan, Natale, & Randler, 2013).

Interestingly, the number of children, as a direct measure of fitness, was related to morning orientation. This suggests that in modern societies with contraception, people have more control over their fertilizations, and thus the decision of having children may be more independent from chronotype or M/E, which is also supported by the correlations between M/E and long-term relationship orientation. Long-term relationship orientation is, in turn, also linked with number of children (in this study). Thus, sexual behavioral aspects that may have led to a higher reproductive success in ancient times (prior to easy means of contraception), such as the number of partners, EPM, or a high unrestricted sociosexuality, were unrelated to reproductive success in this current study. However, as this study is correlational, it may also be the case that having children may shift M/E to an earlier chronotype (e.g., Leonhard & Randler, 2009) and that having more children might cause higher sleep deprivation. Thus, the direction of this effect should be assessed in future studies, probably within a long-term prospective framework, to assess the direction of this effect.

Another aspect may be the use of contraceptives, questioning the number of children as a measure of (potential) reproductive success. Given contemporary contraceptive usage and potential confounds, this could be a misleading proxy for reproductive success. One could argue that in evolutionary history, greater sociosexuality of the evening types would naturally result in greater reproductive success. Therefore, highly promiscuous evening types in modern society may be well versed in avoiding unwanted pregnancies so as to not interfere with this continued unrestricted sociosexuality. Actual age and age at first intercourse are important predictors of the number of

children. This is suggestive because the greater the time span, the greater the probability of having children. Therefore, those who start sexuality earlier and are older have more children because of their longer reproductive period.

The personality variable of extroversion showed an influence (Nettle, 2005) suggesting that extroverted people may have more children than introverted ones. This was confirmed by a large-scale analysis where higher extroversion was associated with both higher number of children and grandchildren in both sexes (Berg et al., 2014). Also, voluntarily childless people scored higher on extroversion compared to parents (Avison & Furnham, 2015). Our results are in line with this previous work and confirm that extroverted people have more children.

Sex differences were found in some traits. Men were slightly older. Age at first intercourse was relatively late, compared, for example, to a survey from the year 2000 (Singh, Wulf, Samara, & Cuca, 2000) but may depend on the sample, which is higher educated when going to the university.

Men were more evening oriented, later chronotypes, and slept shorter. This is in line with previous research on sex differences in chronotype (Randler & Engelke, 2019). There were no differences in SOI-R behavior, but men were less restricted in Attitude and Desire. These results are all in line with previous work. Men scored higher on short-term relationship orientation and women higher on long-term relationship orientation (Schmitt, 2003, 2005). There was no significant difference in number of sexual partners between men and women ($p = .06$). Men reported to have more sex than women, which may result from an overreporting in men or an underreporting in women rather than a real difference.

Conclusion

To some extent, we were able to confirm the hypothesis that evening-oriented people show a higher mating success, which does not lead to a higher reproductive success. In fact, morningness was related to a higher number of children, suggesting that sociosexual behavior and the decision to have children are independent from each other. Also, sex per se was not an influential predictor variable in this relationship, suggesting that it is the evening orientation rather than the sex of the participants which influences number of children and sexual behavior.

Limitations and Strengths

This study is the first one to assess the reproductive success directly by the number of children in addition to sexual behavioral aspects. In addition, further studies should try to sample a higher number of middle-aged people. In addition, collecting data about chronotypes of partners would have been an interesting aspect. The associations from the regression can be considered as low, and the high sample size may lead to the results becoming significant. Therefore, the coefficients should be considered in their size in addition to the significance. However, coefficients in multiple regressions tend to be lower because of shared variance between variables, and size of correlations and coefficients are now interpreted differently and even lower effect sizes are considered to be meaningful (Gignac & Szodorai, 2016, consider correlations of .10, .20, and .30 as relatively small, typical, and relatively large).

Author Contributions

All authors contributed to the study design; Ali Kasaeian and Corina Weidenauer collected the data; Christoph Randler made the analysis and wrote the first draft of the article; and all authors reviewed and contributed to the article.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was partially funded by the Gips-Schüle-Stiftung.

ORCID iD

Ali Kasaeian https://orcid.org/0000-0002-2260-6084
Christoph Randler https://orcid.org/0000-0002-7357-2793

References

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.

Avison, M., & Furnham, A. (2015). Personality and voluntary childlessness. *Journal of Population Research*, *32*, 45–67.

Bateman, A. J. (1948). Intra-sexual selection in drosophila. *Heredity*, *2*, 349–368.

Berg, V., Lummaa, V., Lahdenperä, M., Rotkirch, A., & Jokela, M. (2014). Personality and long-term reproductive success measured by the number of grandchildren. *Evolution and Human Behavior*, *35*, 533–539.

Borkenau, P., & Ostendorf, F. (1993). *NEO-Fünf-Faktoren Inventar: (NEO-FFI); nach Costa und McCrae* [NEO Five-Factor-Inventory (NEO-FFI): based on Costa and McCrae]. Hogrefe, Germany: Göttingen.

Costa, P. T., & McCrae, R. R. (1992). Normal personality assessment in clinical practice: The NEO Personality Inventory. *Psychological Assessment*, *4*, 5.

Díaz-Morales, J. F., Jankowski, K. S., Prokop, P., Castellana, I., Linke, M., Randler, C., & Rahafar, A. (2018). Sleep timing is linked to sociosexuality: Evidence from German, Polish, Slovak, and Spanish females. *Time & Society*. doi:10.1177/0961463X18757390

Díaz-Morales, J. F., & Randler, C. (2017). Spanish adaptation of the Morningness-Eveningness-Stability-Scale improved (MESSi). *The Spanish Journal of Psychology*, *20*. doi:10.1017/sjp.2017.21

Díaz-Morales, J. F., Randler, C., Arrona-Palacios, A., & Adan, A. (2017). Validation of the MESSi among adult workers and young students: General health and personality correlates. *Chronobiology*

International, *34*, 1288–1299. doi:10.1080/07420528.2017.1361437

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

Gangestad, S. W., & Thornhill, R. (1997). The evolutionary psychology of extrapair sex: The role of fluctuating asymmetry. *Evolution and Human Behavior*, *18*, 69–88.

Gignac, G. E., & Szodorai, E. T. (2016). Effect size guidelines for individual differences researchers. *Personality and Individual Differences*, *102*, 74–78.

Gunawardane, K. G. C., Piffer, D., & 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*, *3*, 13.

Hewlett, B. S., & Hewlett, B. L (2010). Sex and searching for children among Aka foragers and Ngandu farmers of Central Africa. *African Study Monographs*, *31*, 107–125.

Hofer, J., Busch, H., Bond, M. H., Campos, D., Li, M., & Law, R. (2010). The implicit power motive and sociosexuality in men and women: Pancultural effects of responsibility. *Journal of Personality and Social Psychology*, *99*, 380–394.

Jankowski, K. S., Díaz-Morales, J. F., & Randler, C. (2014). Chronotype, gender, and time for sex. *Chronobiology International*, *31*, 911–916.

Jankowski, K. S., Díaz-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.

Lameiras Fernández, M., & Rodríguez Castro, Y. (2003). The Big Five and sexual attitudes in Spanish students. *Social Behavior and Personality*, *31*, 357–362.

Leonhard, C., & Randler, C. (2009). In sync with the family: Children and partners influence the sleep-wake circadian rhythm and social habits of women. *Chronobiology International*, *26*, 510–525.

Lesku, J. A., Rattenborg, N. C., Valcu, M., Vyssotski, A. L., Kuhn, S., Kuemmeth, F., . . . Kempenaers, B. (2012). Adaptive sleep loss in polygynous pectoral sandpipers. *Science*, *337*, 1654–1658.

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.

Matchock, R. L. (2018). Evening chronotype is associated with a more unrestricted sociosexuality in men and women. *Personality and Individual Differences*, *135*, 56–59.

McCrae, R. R., & Costa, P. T. Jr. (1999). A five-factor theory of personality. In L. A. Pervin & O. P. John (Eds.), *Handbook of Personality Psychology* (pp. 139–153). New York: Guilford Press.

Miller, G. (2011). *The mating mind: How sexual choice shaped the evolution of human nature*. New York, NY: Anchor books.

Nettle, D. (2005). An evolutionary approach to the extraversion continuum. *Evolution and Human Behavior*, *26*, 363–373.

Penke, L. (2011). Revised sociosexual orientation inventory. In T. D. Fisher, C. M. Davis, W. L. Yarber, & (Eds.), *Handbook of sexuality-related measures* (pp. 622–625). New York: Routledge.

Penke, L., & Asendorpf, J. B. (2008). Beyond global sociosexual orientations: A more differentiated look at sociosexuality and its effects on courtship and romantic relationships. *Journal of Personality and Social Psychology*, *95*, 1113.

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

Poesel, A., Kunc, H. P., Foerster, K., Johnsen, A., & Kempenaers, B. (2006). Early birds are sexy: Male age, dawn song and extrapair paternity in blue tits, *Cyanistes (formerly* Parus*)* caeruleus*. Animal Behaviour*, *72*, 531–538.

Preckel, F., Lipnevich, A. A., Boehme, K., Brandner, L., Georgi, K., Könen, T., . . . Roberts, R. D. (2013). Morningness-eveningness and educational outcomes: The lark has an advantage over the owl at high school. *British Journal of Educational Psychology*, *83*, 114–134.

Putilov, A. A. (2014). What were "owls" doing in our ancestral photoperiodic environment? Chronobiological account for the evolutionary advantage of nocturnal lifestyle. *Biological Rhythm Research*, *45*, 759–787.

Putilov, A. A., Donskaya, O. G., & Verevkin, E. G. (2015). How many diurnal types are there? A search for two further "bird species." *Personality and Individual Differences*, *72*, 12–17.

Rahafar, A., Randler, C., Díaz-Morales, J. F., Kasaeian, A., & Heidari, Z. (2017). Cross-cultural validity of Morningness-Eveningness Stability Scale improved (MESSi) in Iran, Spain and Germany. *Chronobiology International*, *34*, 273–279. doi:10.1080/07420528.2016.1267187

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. (2014). Sleep, sleep timing and chronotype in animal behavior. *Animal Behaviour*, *94*, 161–166.

Randler, C., Díaz-Morales, J. F., Rahafar, A., & Vollmer, C. (2016). Morningness–eveningness and amplitude–development and validation of an improved composite scale to measure circadian preference and stability (MESSi). *Chronobiology International*, *33*, 832–848. doi:10.3109/07420528.2016.1171233

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

Randler, C., & Engelke, J. (2019). Gender differences in chronotype diminish with age: A meta-analysis based on morningness/chronotype questionnaires. *Chronobiology International*, *36* 888–905.

Randler, C., Jankowski, K. S., Rahafar, A., & Díaz-Morales, J. F. (2016). Sociosexuality, morningness–eveningness, and sleep duration. *SAGE Open*, *6*. doi:10.1177/2158244015621958

Randler, C., Schredl, M., & Göritz, A. S. (2017). Chronotype, Sleep behavior, and the Big five personality factors. *SAGE Open*, *7*. doi:10.1177/2158244017728321

Refinetti, R. (2005). Time for sex: Nycthemeral distribution of human sexual behaviour. *Journal of Circadian Rhythms*, *3*, 4.

Rodrigues, P. F. S., Vagos, P., Pandeirada, J. N. S., Marinhoe, P. I., Randler, C., & Silva, C. F. (2018). Initial psychometric characterization for the Portuguese version of the Morningness-Eveningness-Stability-Scale improved (MESSi). *Chronobiology International*, *35*, 1608–1618.

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

Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2003). Life between the clocks: Daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, *18*, 80–90.

Samson, D. R., Crittenden, A. N., Mabulla, I. A., Mabulla, A. Z., & Nunn, C. L. (2017). Chronotype variation drives night-time sentinel-like behaviour in hunter–gatherers. *Proceedings of the Royal Society B: Biological Sciences*, *284*, 20170967.

Schmitt, D. P. (2003). Universal sex differences in the desire for sexual variety: Tests from 52 nations, 6 continents, and 13 islands. *Journal of Personality and Social Psychology*, *85*, 85–104.

Schmitt, D. P. (2005). Sociosexuality from Argentina to Zimbabwe: A 48-nation study of sex, culture, and strategies of human mating. *Behavioral and Brain Sciences*, *28*, 247–275.

Schwarz, S., & Hassebrauck, M. (2007). Interindividuelle Unterschiede in Beziehungspräferenzen: Das Konstrukt Beziehungsorientierung (BZO) und seine Messung [Individual differences in relationship preferences: Relationship orientation and its measurement]. *Zeitschrift für Sozialpsychologie*, *38*, 179–193.

Schwarz, S., Mustafić, M., Hassebrauck, M., & Jörg, J. (2011). Short- and long-term relationship orientation and 2D: 4D finger-length ratio. *Archives of Sexual Behavior*, *40*, 565–574.

Seal, D. W., & Agostinelli, G. (1994). Individual differences associated with high-risk sexual behaviour: Implications for intervention programmes. *AIDS Care*, *6*, 393–397.

Simpson, J. A., & Gangestad, S. W. (1991). Individual differences in sociosexuality: Evidence for convergent and discriminant validity. *Journal of Personality and Social Psychology*, *60*, 870.

Singh, S., Wulf, D., Samara, R., & Cuca, Y. P. (2000). Gender differences in the timing of first intercourse: Data from 14 countries. *International Family Planning Perspectives*, *26*, 21–43.

Smith, D., Schlaepfer, P., Major, K., Dyble, M., Page, A. E., Thompson, J., . . . Ngales, M. (2017). Cooperation and the evolution of hunter-gatherer storytelling. *Nature Communications*, *8*, 1853.

Stewart, S., Stinnett, H., & Rosenfeld, L. B. (2000). Sex differences in desired characteristics of short-term and long-term relationship partners. *Journal of Social and Personal Relationships*, *17*, 843–853.

Tomažič, I., & Randler, C. (2018). Slovenian adaptation of the Morningness-Eveningness-Stability Scales improved (MESSi). *Biological Rhythm Research*. doi:10.1080/09291016.2018.1535539

Walker, R. S., Hill, K. R., Flinn, M. V., & Ellsworth, R. M. (2011). Evolutionary history of hunter-gatherer marriage practices. *PLoS One*, *6*, e19066.

Wiessner, P. W. (2014). Embers of society: Firelight talk among the Ju/'hoansi Bushmen. *Proceedings of the National Academy of Sciences*, *111*, 14027–14035.

Yetish, G., Kaplan, H., & Gurven, M. (2018). Sleep variability and nighttime activity among Tsimane forager-horticulturalists. *American Journal of Physical Anthropology*, *166*, 590–600.

Yetish, G., Kaplan, H., Gurven, M., Wood, B., Pontzer, H., Manger, P. R., . . . Siegel, J. M. (2015). Natural sleep and its seasonal variations in three pre-industrial societies. *Current Biology*, *25*, 2862–2868.