Does chronotype restrict the employment options of creative R&D professionals?

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Abstract

How circadian rhythms affect socio-economic behaviour is little explored but is a promising area of research that could suggest considerable changes in policy making, social norms and individual decision making. This article presents a pilot study of perceived restrictions that sleep patterns set on the employment options of creative research and development professionals. The study is based on ordered probit and ordinary least squares regression modelling on a sample of 153 creative R&D employees from Estonia, with chronotype, sleep duration and various individual and work characteristics as explanatory variables. We find that evening type individuals and those who sleep more hours feel that sleep restricts their work options more than other employees do. Given that there is some genetic background to both morning-evening preference and sleep hours and they are therefore difficult to change, individuals of different chronotypes and with different sleep behaviour may not have equal options in finding employment in creative R&D work.

Keywords: circadian rhythms; sleep; job selection; employment; creative work; R&D

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Introduction

Individuals can be categorised by their inherent circadian rhythms as morning type, neither type or evening type, but all types are often expected to follow similar working schedules. Past research suggests that while 60 per cent of people are neither type, roughly 40 per cent are either morning type or evening type (Adan et al. 2012). This motivates us to investigate in this exploratory pilot study whether the morningness-eveningness type of an individual limits their employment options. Our study draws on a sample of creative research and development employees, who form a distinct group of employees whose work results depend directly on their individual creative abilities and mood, these in turn being dependent on how alert and rested the employee is.

Employability is the likelihood of an individual gaining employment, or whether they become more employable the more they can fit the different demands of jobs (Chan 2000). A wide range of literature (see e.g. Fugate et al. 2004; Hall 2002; Pulakos et al. 2000) suggests that success in a highly competitive labour market with ever-changing job demands requires employees to adapt to the changing environment and manage the changes both in themselves and in the context of their employment. The sleep habits of employees can be one feature that they need to adjust if they want to increase their employability, and we hypothesise that not adjusting those patterns may lead to limited employability.

Recent research suggests that circadian rhythms have a genetic background (Kalmbach et al. 2017; cf. works by 2017 Nobel prize recipients J. Hall, M. Rosbash and M. Young), while various inherent and environmental characteristics may also make a significant contribution to chronotype development (Adan et al. 2012; Kerkhof 1985). Morningness-eveningness appears to depend to some extent on age and related sleep habits, especially among the middle aged (Carrier et al. 1997; Taillard et al. 1999). Past research (Kerkhof and von Dongen 1996) has demonstrated that morningness-eveningness and related time use preferences and behaviours result from a phase difference in the endogenous circadian clock. Previous studies show that evening type employees sleep fewer hours than the morning types (Ishihara et al. 1988) and they are more likely to have worse general health (Paine et al. 2006). Evening types have been

associated with more frequent psychological and psychosomatic disturbances (Randler 2008) and with depression (Merikanto et al. 2016).

Past research has documented a link between genetic factors and sleep duration (Utge et al. 2011; Goel 2017). While a growing number of studies suggest an association between the duration of sleep and employment (Antillon et al. 2014; Ásgeirsdóttir and Ólafsson 2015) and income level (Biddle and Hamermesh 1990; Grandner 2010; Patel et al. 2010; Sedigh et al. 2017; Ásgeirsdóttir and Zoega 2011), there are no known studies on the relationship between morningness-eveningness and employment. Our pilot study seeks to contribute to investigation of that matter while still leaving room for further studies to follow on larger samples from different countries and job types. This study is part of a longer term research agenda of the team, focussing not only on individual but also company level triggers (e.g. Kotšina and Hazak, 2012; Männasoo et al., 2018; Männiste et al., 2011) of success under heterogeneous and competitive conditions.

Data and methods

Study design

The study is based on an online survey consisting of questions on work arrangements, work outcomes, sleepiness, sleep regimen, tiredness, health, and some socio-demographic characteristics. We also asked the respondents for their name, age, gender, education and job details. The research project was approved by the Tallinn Medical Research Ethics Committee on 9 February 2015 by decision No. 894 and informed consent was obtained from all the respondents. The survey was conducted in two waves in spring-summer 2015 and winter 2016.

Sample

The sample was compiled from the 2012 Statistics Estonia data on R&D employees. The target category for this study of creative employees is the category “researchers” in the Statistics Estonia classification of R&D employees, while the categories “technicians” and “supporting staff” are excluded. There were an average of 4.4

thousand full time equivalent creative R&D employees in the category "researchers" in Estonia in 2010-2014.

We have excluded from that population the 3.4 thousand or so employees working in higher education and healthcare, and those employed at microentities and research institutes with fewer than 15 creative R&D employees. This is because the teaching schedules in higher education, the appointments and procedures at medical institutions, and the working practices at microentities mean that their work arrangements are quite specific and may therefore interfere with the work, sleep, health and leisure time decisions that our project is targeted at. This leaves the population of creative R&D employees of interest for our study at approximately 1.0 thousand. Those employees work for 23 Estonian employers in both the private and public sectors, and they comprise applied researchers, product developers, IT developers and other creative R&D employees at private R&D companies, banks and technology and IT companies, and at public research institutes. All of these employers were invited to participate in this study, and 11 employers, or 48%, accepted the invitation. All the 807 employees from these 11 organisations were invited to participate, and 287 of them agreed to do so. In total 217 employees completed the survey in at least one of the two waves, giving an overall response rate of 76% of all those who had agreed to participate.

Of the 217 participants, 34 appeared in both the first and second waves of the survey. We performed Mann–Whitney U tests (Mann and Whitney, 1947) to establish the statistical significance of the differences between the two waves in how sleep was perceived to restrict work options by the recurring respondents (cf Jankowski 2017), and we found these differences to be statistically insignificant. Because of this we have pooled the data from the two waves of the survey for the regression analysis and we selected randomly which of the two responses from the 34 recurring participants to use.

Additional eliminations from the sample of unique participants were made because of logical inconsistencies in the responses or because the respondent was identified from certain control questions incorporated in the survey questionnaire as not being sufficiently engaged in R&D for their employer. After all these exclusions the final sample consists of 153 employees, which equals 53% of those who agreed to participate in the survey. Of these 153 employees, 79% work in the private sector, with 35 in the technology industry, 21 in IT, 43 in the product or IT development units at

banks, and 22 in R&D companies. Public R&D institutes employ 21% of the participants. Given that the final sample was not selected randomly from the total population of interest, we have weighted the observations in the sample to match it with the population of interest for the employer's area of activity and the employee's gender. As the Statistics Estonia dataset tells us the gender split of the employees and the distribution of the employers by their area of activity in the total population of around 1.0 thousand creative R&D employees of interest for our study, we have assigned a weight to each observation in our final sample to reflect the gender and area of activity characteristics of the observation so that the gender distribution of employees and area of activity distribution of the employers in the weighted sample matches the population of interest.

Dependent and explanatory variables

We are interested in how much employees feel that their chronotype sets constraints on their employment. We asked the respondents to answer the question "To what extent do you feel that your sleep cycle limits or has limited your work options?" on a 5-level Likert type scale ranging from "Not at all"=0 to "Totally"=5, which gives the dependent variable *restriction*.

The selection of independent variables is primarily derived from the previous literature. The score of the Reduced Morningness-Eveningness Questionnaire (*meq*; see Adan and Almirall, 1991) reflects the circadian rhythm of the employee. Average sleep hours captures actual daily sleep patterns. The respondent's age, their gender, whether they live alone, how many children younger than school age they have and their level of education have been incorporated as key control variables for socio-demographic characteristics, while the *phealth* variable controls for the general health of the employee. The creative intensity desired for work is another explanatory variable that seeks to capture the creative nature of the work that the employee prefers. The dependent and explanatory variables are outlined in Table 1 and the pairwise correlation matrix of the variables is presented in the Appendix.

Table 1. Model variables (mean and standard deviation shown for continuous and ordered variables; percentage of respondents shown for binary and categorical variables)

Variable	Description	All: Mean/% (Std. Dev.)	Men: Mean/% (Std. Dev.)	Women: Mean/% (Std. Dev.)
	N	**153 (100%)**	**87 (57%)**	**66 (43%)**
Dependent				
restriction	To what extent do you feel that your sleep cycle limits or has limited your work options?			
	"Not at all" (=1)	67%	64%	70%
	"To a small extent" (=2)	24%	24%	24%
	"Somewhat" (=3)	7%	9%	3%
	"To a large extent" (=4)	3%	2%	3%
Explanatory				
meq	Reduced Morningness-Eveningness Questionnaire (Adan and Almirall, 1991) score, 1…25 scale ranging from "Definitely an evening type" to "Definitely a morning type"	14.73 (3.53)	14.98 (3.57)	14.39 (3.49)
sleephours	Employee reported average sleeping hours per day on the scale:			
	"Less than 6 hours" (=1, base)	7%	6%	8%
	"6-6.9 hours" (=2)	50%	49%	50%
	"7-7.9 hours" (=3)	38%	39%	36%
	"8-8.9 hours" (=4)	6%	6%	6%
	"at least 9 hours" (=5, none in the sample)	0%	0%	0%
age	Age in years	38.76 (11.51)	37.72 (12.19)	40.12 (10.48)
gender	Male (=1) or female (=0)	57%	100%	100%
alone	The employee lives alone (=1) or does not (=0)	25%	24%	26%
children	Employee-reported number of children younger than school age living together with the employee	0.38 (0.66)	0.40 (0.71)	0.35 (0.59)
phealth	First principal component score of general health (with overall Kaiser-Meyer-Olkin measure of sampling adequacy of the factor 0.6), comprising:	0.00 (1.41)	0.11 (1.39)	-0.15 (1.45)
	(1) "Do you have high blood pressure or have you ever used medicine for high blood pressure?" (yes=1)	20%	22%	18%
	(2) "Do you suffer or have you suffered from illnesses that significantly affect your mental fatigue?" (5-level Likert type scale, "Never"=1, "Often"=5)	1.71 (0.95)	1.75 (0.97)	1.67 (0.93)
	(3) "Does any illness or injury interrupt you while doing your daily job?" (5-level Likert type scale, "No obstacles"=1, "Not able to work"=5)	1.58 (0.73)	1.57 (0.77)	1.58 (0.68)
	(4) "How many workdays have you been absent from work due to illness or medical examination in the past 12 months?"(5-level scale, "None" = 1, "100-365 days" = 5)	1.75 (0.72)	1.77 (0.69)	1.71 (0.76)
	(5) Body-Mass Index (continuous)	24.65 (3.90)	25.35 (3.11)	23.72 (4.61)
education	Years of education starting from primary education	16.58 (2.65)	15.97 (2.85)	17.39 (2.14)
creative	Share of creative work desired by the employee in total working time of the employee (%)	71.70 (20.49)	71.18 (21.03)	72.38 (19.90)

We used Stata version 14 (StataCorp, USA) for the Ordinary Least Squares (OLS) estimations with *restriction* as a continuous variable and ordered probit maximum likelihood estimations with *restriction* as an ordered discrete category, incorporating the explanatory variables outlined in Table 1.

Results

The results of the OLS (Models 1 and 2) and ordered probit (Models 3 and 4) regression analysis are presented in Table 2 along with the Shorrocks-Shapely decomposition (Shorrocks, 1982) of R^2 (OLS Model 1) and pseudo-R^2 (ordered probit Model 3). The ordered probit estimations provide an alternative approach to the OLS results and a robustness check for them, given that the dependent variable has skewed and non-normal patterns of distribution (as can be seen from Table 1). While Models 1 and 3 incorporate *meq* and *sleephours* as individual explanatory variables, Models 2 and 4 provide an alternative view with the interaction terms of *meq* and *sleephours*. However the R^2 of the OLS Model 1 is higher than that of Model 2, and the pseudo-log-likelihood of the ordered probit Model 3 is lower in absolute terms than that of Model 4, suggesting that Models 1 and 3 outperform Models 2 and 4.

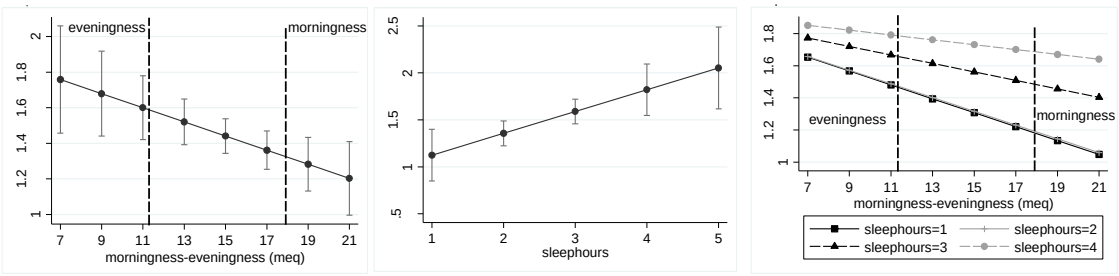
Table 2. OLS and ordered probit estimates of *restriction*.

Estimation	**Model 1 OLS**	**R^2 decomp.‡**	**Model 2 OLS**	**Model 3 Ordered probit**	**Pseudo-R^2 decomp.‡**	**Model 4 Ordered probit**
meq	-0.040*	0.036		-0.075*	0.018	
	(0.02)			(0.03)		
sleephours	0.232*	0.028		0.477*	0.016	
	(0.10)			(0.20)		
sleephours=1 # meq			-0.043			-0.072
			(0.04)			(0.07)
sleephours=2 # meq			-0.043*			-0.091*
			(0.02)			(0.04)
sleephours=3 # meq			-0.026			-0.048
			(0.02)			(0.03)
sleephours=4 # meq			-0.015			-0.031
			(0.02)			(0.03)
age	-0.011	0.038	-0.012	-0.026	0.026	-0.028
	(0.01)		(0.01)	(0.02)		(0.02)
gender (Male=1)	0.035	0.000	0.038	0.013	0.002	0.032
	(0.09)		(0.09)	(0.18)		(0.18)
alone (Living alone=1)	-0.178	0.000	-0.198*	-0.477	0.001	-0.550*
	(0.11)		(0.10)	(0.27)		(0.25)
children	-0.051	0.000	-0.077	-0.128	0.000	-0.200
	(0.09)		(0.10)	(0.19)		(0.20)
phealth (1st PC)	0.113*	0.035	0.104	0.190*	0.018	0.169*
	(0.05)		(0.06)	(0.09)		(0.09)
education	0.017	0.001	0.020	0.039	0.001	0.052
	(0.02)		(0.02)	(0.04)		(0.04)
creative	-0.004	0.003	-0.004	-0.010	0.003	-0.009
	(0.00)		(0.00)	(0.01)		(0.01)
constant	1.901**		2.360**			
	(0.46)		(0.39)			
R^2 / pseudo-R^2		0.189	0.178		0.132	0.130
pseudo-log-likelihood					-118.9	-119.1
F-test / p Wald's chi^2	**		**	**		**
N	153		153	153		153

*Notes: *p≤0.05, **p≤0.01; ‡Shorrocks-Shapely decomposition of R^2 (Model 1) and pseudo-R^2 (Model 3)*

We find from both of the Models 1 and 3 that morning-evening preference is an important driver of the perceived restrictions that the sleep regimen puts on employment (see Table 2). The non-parametric Mann–Whitney U test (Mann and Whitney, 1947) that does not assume normal distribution shows that at the 95% confidence level (p=0.05) there is a statistically significant difference between evening types (*meq*≤11 – moderately to definitely evening type) and morning types (*meq*≥18 – moderately to definitely morning type) in that perception. Evening type individuals expressed a stronger perception that their sleep regimen limits or has limited their employment opportunities than morning types did. Figure 1 illustrates the levels of an individual feeling that their sleep regimen has limited their work options.

Figure 1. The levels of an individual perceiving that their sleep regimen limits their work options for different levels of morningness-eveningness (left) and sleep hours (middle) and the combination of the two (right) (adjusted estimates at means with 90% confidence intervals)



Hours of sleep are strongly related to perceived constraints on work options caused by sleep patterns. The more hours an individual sleeps each night, the more they feel the limitations that their sleep regimen sets on job selection. This relationship is illustrated in Figure 1 for each category of *sleephours*, and it is evident from both the OLS and ordered probit estimates in Models 1 and 3.

General health is another robust predictor of the perception of employment limitations related to sleep. The better the general health of the employee is, the lower the probability that those restrictions are felt.

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Discussion

The link identified between individual chronotype and the availability of work options is a novel result. That evening type individuals feel that their sleep regimen sets significantly higher limitations on their employment options than morning types do hints that certain jobs with the standard nine-to-five work routine may remain difficult for the evening type people to access. As recent research (e.g. Kalmbach et al. 2017) suggests that circadian rhythms have some genetic background, a potential explanation is that it may be difficult for an individual to adjust their chronotype to align it with standard working hours, which in turn may narrow the job opportunities for that person. Unless the employer allows flexible working time without penalising it with a lower salary or otherwise adverse terms of employment, an evening type individual might not be able to take the job without making potentially large sacrifices in their sleeping time preferences. A study on the same sample data reveals that the creative work outcomes of both clearly evening types and clearly morning types are significantly greater than those of the neither types while evening type employees perceive with a significantly higher probability that work limits their sleep to a large extent (Hazak et al. 2018), suggesting that the more intensely perceived limitations on the employment of evening types cannot be explained by their productivity being lower. Further studies are needed to confirm the relationship between an individual's chronotype and employment using larger samples from different countries and job types. The results of our exploratory pilot study point, however, to a societally important issue of evening type individuals potentially not having equal options in finding employment in creative R&D work because of their inherent circadian rhythms, which are hard to adjust to the prevailing regulations and social norms for the timing of work.

A possible explanation for the positive relationship between sleeping hours and the probability of the individual perceiving sleep related constraints on their work options is that relatively long sleeping hours constrain the individual in their choice of job when the start or end time of work is not in alignment with their sleeping patterns, especially when there are fewer hours in the day that can be dedicated to work. This finding is in alignment with the theoretical arguments of the literature on the economics of sleep (e.g. Asgeirsdottir and Zoega 2011). The suggestion can be drawn from the growing literature on the genetic background of the duration of sleep (Utge et al. 2011;

Goel 2017) and its linkages with chronotype (Ishihara et al. 1988) that sleeping hours may be hard for a person to adjust. This may limit the employment options of the individual as work with an inconvenient duration or timing would interfere with their natural sleeping patterns. Those who are not ready to make sacrifices in their sleeping time may thus feel constrained in their work options. These findings are overall in alignment with the arguments presented in the earlier literature (Antillon et al. 2014; Ásgeirsdóttir and Ólafsson 2015).

The control variables that exhibit a significant relationship with perceived constraints on employability related to sleep point in the expected directions, given the past research (Monk et al. 1994; Yadav et al. 2017; Sedigh et al. 2017). Employees living alone appear less constrained in their employability than are people with families, who have various family obligations and must obey the time use patterns and preferences of other family members, which can then affect their sleep. This finding is in line with another study on the same sample data (Virkebau and Hazak 2017; Hazak et al. 2016), which shows that people living alone are significantly less likely actually to use flexible working options than employees with families are. General health may have similar effects, as individuals with weaker general health may feel constrained in their work by their inability to meet the job requirements because of lost or otherwise anomalous sleep (see Lauderdale et al. 2016), and employers may not opt for employees with health issues when they are recruiting. Both these findings point to important policy issues, as the employment of people regardless of their health or family status is high on the political agenda. Sleep may be a potential mediator of limitations in employability driven both by health and by family status.

We acknowledge that the small size of the sample and the relatively low participation rate of employers and employees in the survey are limitations of our study, but we are quite confident that the results of the research are representative of creative R&D employees in Estonia because of the careful design of the study population as discussed above and the fully observed results. We note however that the share of employees who perceive their opportunities for work to be constrained by sleep factors is relatively small (see Table 1), which limits our ability to achieve strongly statistically significant results. Another limitation of the study is that the members of the target population could only be included in the sample if their employer agreed to take part in

the study. Furthermore, there may be selection bias because of differences between those respondents who completed the survey and those who in the end did not. These selection biases are tackled by weighting the sample for the respondent's gender and the employer's area of activity in order to align the sample with the characteristics of the target population. Clustering standard errors by employer-gender interaction terms in the models further contributes to the identification of any unobserved dependencies in the clusters by employer and gender. It is not impossible though that there remain some selection biases, and expanded studies on different samples in other countries or jobs remains a promising avenue for research in the future.

Conclusions

How circadian rhythms affect socio-economic decision making is a promising area of research that could lead to considerable changes being made in policy making, social norms and individual behaviour. This article presents a pilot study on the constraints on employability that individuals perceive from their morning-evening preference. We find that evening type individuals and those who sleep more hours feel significantly more intensely that their sleep cycle restricts their work options. Given that there is some genetic background to both morning-evening preference and sleep hours and they are therefore difficult for the individual to change, individuals of different morningness-eveningness types and with different sleep patterns may not have equal options in finding employment in creative R&D work. However, this phenomenon would need to be confirmed by further research as our pilot study is based on a limited sample of 153 Estonian creative research and development employees. Consideration of individual characteristics in circadian rhythms and sleep preferences is important not only for achieving improvements in individual wellbeing but also for helping the labour market and human resources management function more fairly and efficiently.

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Appendix

Pairwise linear correlations (correlation coefficients for each pair of variables the with p-values below)

	restriction	meq	sleep-hours	age	gender	alone	children	phealth	education
meq	-0.2081								
	0.0098								
sleephours	0.1556	0.1350							
	0.0548	0.0962							
age	-0.2167	0.3030	-0.0584						
	0.0071	0.0001	0.4733						
gender	0.0679	0.0820	0.0276	-0.1035					
	0.4042	0.3137	0.7347	0.2031					
alone	-0.0028	-0.0110	-0.0515	-0.0657	-0.0186				
	0.9722	0.8924	0.5272	0.4199	0.8198				
children	-0.0157	-0.0087	-0.1419	-0.0893	0.0406	-0.2857			
	0.8469	0.9150	0.0802	0.2723	0.6185	0.0003			
phealth	0.1646	-0.0192	-0.0779	0.2039	0.0910	0.0022	-0.0668		
	0.0420	0.8133	0.3383	0.0115	0.2635	0.9784	0.4120		
education	-0.0544	-0.0039	0.0056	0.2972	-0.2671	-0.0349	-0.1493	-0.0167	
	0.5039	0.9618	0.9448	0.0002	0.0008	0.6687	0.0655	0.8378	
creative	-0.0701	-0.0368	-0.0834	0.1921	-0.0290	0.1966	-0.0855	0.0333	0.2701
	0.3893	0.6520	0.3053	0.0174	0.7222	0.0149	0.2932	0.6829	0.0007