CIRCADIAN TYPOLOGY IS RELATED TO RESILIENCE AND OPTIMISM IN HEALTHY ADULTS

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ABSTRACT

The relationships between circadian typology and several aspects related to mental health, such as satisfaction with life, emotional intelligence, perceived well-being and psychopathological symptomatology have been documented. However, their relationships with two psychological strengths such as resilience and optimism have not been examined yet. Therefore, the purpose of the present study was to explore whether circadian typology is related to both measures, taking into consideration the possible influence of sex. A sample of 1922 participants (978 men), aged between 18 and 60 yrs (30.08 ± 10.53) completed the reduced Morningness-Eveningness Questionnaire (rMEQ), the 10-item Connor-Davidson Resilience Scale (10-item CD-RISC) and the Life Orientation Test-Revised (LOT-R). Circadian typology is associated with different values in resilience ($F_{(2,1915)} = 45.89$; $p < .001$; $\eta_p^2 = .046$) and optimism ($F_{(2,1915)} = 37.74$; $p < .001$; $\eta_p^2 = .038$), independently of the sex. Morning-type subjects showed the highest resilience and optimism scores while the lowest scores were shown by evening-type, exhibiting the neither-type subjects intermediate scores ($p < .007$, in all cases). These results suggest that evening-type subjects could display less capacity to face adversity and adapt positively, as well as less expectance of the occurrence of positive events compared to neither and morning-type individuals. In addition, these results provide new evidence that might improve our understanding about the relationships between circadian typology and psychological traits and disorders. Although future works with longitudinal designs are needed, the obtained results emphasize that the evening-type could be a risk factor for the development of psychological problems and mental disorders, whereas the morning-type could be considered as a protective factor.

Keywords: Circadian typology; Morningness-eveningness; Resilience; Optimism; Mental health; Psychological strengths.

INTRODUCTION

During the last years there has been increased interest in studying the relationships between differences in circadian rhythmicity or morningness-eveningness and mental health. Several factors were related to the eveningness orientation such as less quality of life (Roeser et al., 2012), satisfaction with life (Díaz-Morales et al., 2013), well-being (Haraszti et al., 2014), lower emotional intelligence (Antúnez et al., 2013), personality traits associated to risk behaviors (Antúnez et al., 2014; Tonetti et al., 2009), more psychological symptoms (Prat & Adan, 2013; Vardar et al., 2008) and psychopathological diseases (Adan, 2013; Bullock et al., 2014; Merikanto et al., 2013; Randler, 2011).

The morningness-eveningness dimension, which seems to follow a normal distribution (Natale & Cicogna, 2002), allows for classifying individuals in three circadian typologies: morning-, neither-, and evening-type. The morning-type subjects tend to wake up and go to bed earlier and show a phase advance of their biological and behavioral circadian functions when compared to the evening-type. The neither-type population has been scarcely studied, but tends to maintain an intermediate position. The phase differences between extreme groups may vary from 2 to 12 h depending on the parameters considered (e.g. sleep-wake, body temperature, cortisol, and melatonin) (Adan et al., 2010; Adan et al., 2012). These differences are associated with individual differences in the functioning of the endogenous circadian system (Levi & Schibler, 2007) which is more adjusted to the light-dark cycle in the morning-type. Likewise, these differences have shown an important impact in mental health: Morning-type have been proposed as a protective factor for the development of psychopathology, while evening-type have been proposed as a risk factor for the development of mental health problems (Adan et al., 2012), which could be explained by the

social jet-lag (Wittmann et al., 2006), defined as the desynchronization between the biological and the social clock. Age and sex differences in circadian typology have been also found. Large-size studies have shown that men exhibit a more pronounced tendency to eveningness than women (Adan & Natale, 2002; Tonetti et al., 2008), and this has also been evidenced by assessing the circadian rhythmic expression (Adan & Sánchez-Turet, 2001; Duffy et al., 2011). Moreover, during the adulthood and over the years, the tendency to morningness is progressively increased (Adan et al., 2012).

The term resilience origins from the Latin verb *resilire*, which means "to jump back". Resilience is defined in the Oxford Dictionary of English as being "able to withstand or recover quickly from difficult conditions" (Soanes & Stevenson, 2010). There is no consensus about the psychological scientific definition of resilience but most of the researchers agreed that most of the resilience definitions are based around two core concepts: Adversity and positive adaptation (Fletcher & Sarkar, 2013). Resilience could be understood as a trait or as a process. The first consists in a group of characteristics that vary with time, age, gender, context, and culture enabling individuals to adapt to the circumstances they encounter, being defined as "the personal qualities that enable one to thrive in the face of adversity" (Connor & Davidson, 2003). The second consists in a process that changes over time and is defined as "a dynamic process encompassing positive adaptation within the context of significant adversity" (Luthar et al., 2000).

Similarly to what happened with resilience definitions, several resilience models and theories have been developed along the last decade. The resiliency model (Richardson, 2002) has been widely accepted due to its potential application to different type of stressors. Starting at a point of biopsychospiritual homeostasis or "comfort zone", disruptions applied to this

state force the individual to adjust and begin the reintegration process, leading one of four outcomes: 1) Resilient reintegration (adaptation to disruption leads to a new and higher level of homeostasis); 2) reintegration back to homeostasis (subject clings to the comfort zone, "just get past" a disruption); 3) reintegration with loss (establishing a lower level of homeostasis); or 4) dysfunctional reintegration (maladaptive strategies such as substance abuse and other destructive behaviors).

The relationship between resilience and sex is unclear. Although sex differences have been reported (Yu et al., 2011), there is also evidence of absence of relationship (Jowkar et al., 2010). On the other hand, resilience has been associated to several aspects of mental health like suicide risk (Roy et al., 2011), substance use (Fadardi et al., 2010), depression and anxiety (Goldstein et al., 2013; Haddadi & Besharat, 2010, Scali et al., 2012), self-esteem and coping strategies (Steinhardt & Dolbier, 2008), temperament and character (Kim et al., 2013), distress and psychological well-being (Haddadi & Besharat 2010; Salehi et al., 2010).

Dispositional optimism was defined by Scheier & Carver (1985) as a stable and generalized expectation of an individual for the occurrence of future positive events. Thus, optimists are people who expect good things to happen to them while pessimists are characterized by the opposite. Moreover, optimism appears to confer resilience to stressful life events (Carver et al., 2010). Optimism and its relationship to sex and to psychological health have been widely evaluated. Studies examining the relationship between optimism and sex have found marginal or absent differences (Herzberg et al., 2006; Zenger et al., 2013). To date is well established that optimism is strongly related to quality of life (Kostka & Jachimowicz, 2010), well-being (He et al., 2013), life satisfaction (Extremera et al., 2009; Jiang et al., 2014), coping strategies (Nes & Segerstrom, 2006), emotional intelligence

(Extremera et al., 2009), substance use (Hamvai & Piko, 2010) and to several psychological problems (Sánchez-Hernández et al., 2010).

The aim of this work was to examine, for first time, the relationships among circadian typology, resilience and optimism, taking into account the possible influence of sex, in a wide sample of healthy Spanish adults without physical or mental pathology. We hypothesize that morning-type subjects will score higher than evening-type in both measures.

METHOD

Participants

The participants were 1922 adults residing in Spain, aged 18-60 (30.08 ± 10.53 yrs), 978 (50.9%) men and 944 (49.1%) women. Significant differences were observed in age between men (29.16 ± 10.12 yrs) and women (31.03 ± 10.86 yrs) ($t_{(1920)} = 3.92$; $p < .001$; Cohen's $d = .18$). Subjects were not paid for participating in the study and they all gave their informed consent prior to the inclusion in the study. Subjects completed on-line questionnaires of circadian typology, resilience and optimism, and provided information about sociodemographic variables and presence of physical or mental pathology. Only subjects who completed the questionnaires and fulfilled the inclusion criteria (residing in Spain, absence of health problems and age between 18 and 60 yrs) were included in the analysis. Of the total amount of 2419 subjects who participated, 497 (20.55%) were excluded due to duplicate answers and for failing to accomplish the inclusion criteria. The Research Committee of the University of Barcelona approved the protocol, and the present study complied with the tenets of the Declaration of Helsinki and the international ethical standards of chronobiological research (Portaluppi et al., 2010).

Measurement instruments

Circadian typology was assessed using the reduced Morningness-Eveningness Questionnaire (rMEQ), standardized for the Spanish population (Adan & Almirall, 1991). This test is composed of five items, and the total scores range from 4 to 25 points. Subjects can be assigned to one of the three possible circadian typologies (i.e. morning-, neither-, or evening-type) according to the cutoff score: 4-11 points for the evening-type, 12-17 for the neither-type, and 18-25 for the morning-type. The Spanish rMEQ is a reliable measure to classify individuals in the morningness-eveningness dimension (Di Milia et al., 2013) and its internal reliability for the present sample was adequate (Chronbach's $\alpha = .79$).

The resilience assessment was performed by using the Spanish version of the 10-item Connor-Davidson Resilience Scale (10-item CD-RISC) (Connor & Davidson, 2003). This scale, which uses the scheme outlined by Richardson (2002), is composed of ten items and the total scores range from 0 to 40. The 10-item CD-RISC shows good psychometric properties and can be used as a reliable and valid instrument for measuring resilience (Campbell-Sills & Stein, 2007; Notario-Pacheco et al., 2011). The internal reliability for the present sample was adequate (Chronbach's $\alpha = .85$).

Optimism was assessed using the Spanish version of the Life Orientation Test-Revised (LOT-R) (Perczek et al., 2000; Scheier et al., 1994). This test is composed of ten items with total scores ranging from 10 to 50 points and may be used as a reliable and valid instrument for assessing optimism due to its appropriate psychometric properties (Ferrando et al., 2002). Likewise, the internal reliability for the present sample was adequate (Chronbach's $\alpha = .76$).

Data analysis

Two analysis of covariance (ANCOVA) were performed: One for the 10-item CD-RISC and another for the LOT-R. The scores of 10-item CD-RISC and LOT-R were considered as dependent variables, taking circadian typology and sex as factors, whereas age was considered as a covariable to control for possible effects. The partial eta square η_p^2 was obtained as a measure of the ANCOVA effect size, considering that a η_p^2 of .01 is small, .04 moderate, and .10 large (Huberty, 2002). Post hoc comparisons were performed by Bonferroni's test and their effect size were calculated using Cohen's *d*, considering that a Cohen's *d* of .2 is small, .5 moderate, and .8 large (Cohen, 1988). Spearman's correlations were computed between the rMEQ, 10-item CD-RISC and LOT-R scores to assess bivariate relationships. Multiple regression analyses were performed for LOT-R and 10-item CD-RISC in order to examine their relationships with circadian typology and sex. Statistical analyses were performed using the SPSS/PC+ statistics package (version 17.0; SPCC, Chicago, IL, USA), and statistical tests were bilateral with type I error set at 5%.

RESULTS

Sociodemographic data

The distribution of subjects in the circadian typology groups was 421 in the morning-type (21.9%; 165 men and 256 women), 968 in the neither-type (50.4%; 497 men and 471 women), and 533 in the evening-type (27.7%; 316 men and 217 women). The distribution of the rMEQ scores was skewed toward eveningness ($z = 3.27$, $p < .001$). Significant differences were shown between men (13.18 ± 0.14) and women (14.63 ± 0.14) in rMEQ scores ($t_{(1,1920)} = 7.41$, $p < .001$, Cohen's $d = 0.34$). Moreover, the circadian typology groups differed

significantly in age ($F_{(2,1919)}$ = 164.31, p < .001, η_p^2 = .146). Post hoc comparisons showed that morning-type subjects (37.02 ± 11.50) were older than neither- (29.51 ± 10.01) and evening-type (25.64 ± 7.43) (p < .001; Cohen's d > .69, in all cases). Likewise, neither-type were older than evening-type (p < .001; Cohen's d = .44).

Sociodemographic data (employment and marital status) according to sex and circadian typology are shown in Table 1. A higher proportion of workers was observed in the morning-type group. Likewise, singles are prevalent in the evening-type group while paired are in the morning-type group as well as in the women group.

Insert Table 1

Resilience

Descriptive data for the total sample and for sex and circadian typology groups in the 10-item CD-RISC are shown in table 2. Only a main effect for circadian typology was observed, while no interaction between circadian typology and sex was found. Post hoc comparisons showed higher resilience scores in the morning-type group compared to the evening- (3.92, p < .001, Cohen's d = .68) and neither-type (1.50, p < .001, Cohen's d = .27). Neither-type exhibited higher resilience scores than the evening-type (2.43, p < .001, Cohen's d = .40).

Insert Table 2

Optimism

Table 2 shows descriptive data for the total sample and for sex and circadian typology groups in the LOT-R. We observed significant main effects for sex and circadian typology but no interaction between both. Post hoc comparison showed higher optimism scores in

women compared to men (0.65, $p = .004$, Cohen's $d = .24$). Likewise, post hoc comparisons showed higher optimism scores in the morning-type group compared to the evening- (2.63, $p < .001$, Cohen's $d = .77$) and neither-type (0.86, $p = .006$, Cohen's $d = .31$). Neither-type showed higher optimism scores than the evening-type (1.77, $p < .001$, Cohen's $d = .45$).

Correlation and regression analyses

rMEQ scores showed a significant positive correlation with 10-item CD-RISC scores ($r_s = .220$, $p < .001$) as well as with LOT-R scores ($r_s = .259$, $p < .001$). Likewise, 10-item CD-RISC scores were significantly correlated with LOT-R scores ($r_s = .489$, $p < .001$). Multiple regression analyses revealed that sex was significantly related to LOT-R scores ($R^2 = .014$, $F_{(1,1920)} = 27.38$, $p < .001$) and that rMEQ scores were significantly related to 10-item CD-RISC scores ($R^2 = .054$, $F_{(1,1920)} = 109.81$, $p < .001$), and to LOT-R scores ($R^2 = .069$, $F_{(1,1920)} = 142.88$, $p < .001$).

DISCUSSION

This study examined, for the first time, the relationships among circadian typology resilience and optimism, taking into account the possible influence of sex, in a large sample of healthy Spanish subjects with a good representation of both sexes. The distribution of subjects according to the morningness-eveningness dimension was more skewed to the eveningness pole as compared with earlier studies using Spanish adult samples (Antúnez et al., 2013; Adan et al., 2012).

Regarding the results obtained among circadian typologies in resilience, our findings support the hypothesis that morning-type subjects show the highest and evening-type the

lowest capacity to face adversity and adapt positively, while neither-type subjects capacity is between both extreme groups. Likewise, according to the regression results, we found that the closer is one to the morningness pole, the greater tendency to show higher capacity to face adversity and adapt positively, and vice versa. In accordance with a previous study (Jowkar et al., 2010), no sex differences were found. Therefore, the results of circadian typology seem to be independent of the sex of the participants.

The obtained results in resilience allow us to link the morning-type to all those characteristics which are classically associated to a greater resilience, such as self-esteem and coping strategies (Steinhardt & Dolbier, 2008) and psychological well-being (Haddadi & Besharat 2010; Salehi et al., 2010). Likewise, the evening-type could be linked with those which are associated to a lower capacity to face adversity and adapt positively, such as psychological distress (Haddadi & Besharat 2010), drug consumption (Fadardi et al., 2010), depression, anxiety and suicide risk (Goldstein et al., 2013; Haddadi & Besharat, 2010; Roy et al., 2011; Scali et al., 2012).

Moreover, the evening-type has also been related to psychological problems and symptoms (Prat & Adan, 2013; Vardar et al., 2008), mainly mood disorders (Merikanto et al., 2013) and substance use disorders (Adan, 2013), being proposed as a risk factor for the development of those. One of the most accepted theories which explain these relationships is the social jet-lag (Wittmann et al., 2006), wherein the social jet-lag sufferers, who are mainly evening-type (Wittmann et al., 2006), must set up strategies in order to adapt to or palliate the desynchronization between the social and their biological clock. Thus, the lower resilience showed by the evening-type could be translated into an unsuccessful face of this adversity becoming into a dysfunctional reintegration (maladaptive strategies such as

substance use and other destructive behaviors) which could explain the relationships presented above.

The optimism results support the hypothesis of a greater capacity to expect good things to happen in the morning-type, which is in contrast with the lower capacity observed in the evening-type, while neither-type is in an intermediate position. In this line, and according to the regression results, we also found that the morningness-eveningness -considered as a dimension- was positively related to optimism. Moreover, in accordance with previous studies (Herzberg et al., 2006), women showed marginal but higher LOT-R scores than men. Nevertheless, the absent of interaction between sex differences and circadian typology suggests that the results are independent of the sex.

The well-known relationships between optimism and other healthy characteristics such as higher quality of life (Kostka & Jachimowicz, 2010), well-being (He et al., 2013), life satisfaction (Jiang et al., 2014, Extremera et al., 2009), emotional intelligence (Extremera et al., 2009), less drug consumption (Hamvai & Piko, 2010) and psychological problems (Sánchez-Hernández et al., 2010), combined with the new spotted association with circadian typology, underline the morning-type as a healthier typology which could be considered as a protective factor for the development of psychological problems. By contrast, the evening-type could be considered as a risk factor, especially for the development of mood and substance use disorders.

Together, our resilience and optimism results could provide additional evidence in order to improve the understanding of the relationship between circadian typology and different psychological characteristics. On the one hand, the higher and lower resilience and optimism observed in morning- and evening-type, respectively, could be mediating the

existing association between both circadian typologies with persistence (Antúnez et al., 2014) and conscientiousness (Tonetti et al., 2009). In this sense, the tendency to maintain a behavior in extinction conditions or to aim for an achievement behavior could be easily disturbed in those people with a lower capacity to face the adversity and adapt positively or in those that expect that nothing good will happen (evening-type), and vice versa (morning-type). On the other hand, the existing relationship between circadian typology and mood or substance use disorders could be also mediated by resilience and optimism. Evening-type subjects are more prone to suffer depressive symptomatology (Merikanto et al., 2013) and substance use (Adan, 2013), which could be explained by the difficulties (as compared to morning-type) to face the adversity and adapt positively, as well as by the tendency to expect that not so many good things will happen.

Some limitations for this study should be addressed in future research. First of all, we highlight the relative absence of control of the on-line data collection as compared with the traditional face-to-face questionnaires. Likewise, those populations without an Internet connection were unable to participate in the study, which reduces the sample diversity. Finally, the presence of physical and psychological problems was assessed by self-report questionnaires and not by physical exam and psychiatric interview.

To sum up, this is the first study assessing the relationships among circadian typology, resilience and optimism in a wide sample of healthy adults. Morning-type subjects showed the highest levels of resilience and optimism, evening-type showed the lowest and neither-type hold an intermediate position between both extreme groups. The results emphasize, in healthy subjects, that the circadian typology is related to psychological strengths. Thus, the morning-type could be a protective factor for the development of psychological problems

and the vulnerability of the evening-type for the development of those (mood and substance use disorders, specifically) is highlighted. In addition, our findings could improve the comprehension of the relationships between circadian typology and different psychological characteristics by offering new possible explanations for them. Moreover, our results could become a useful tool for healthcare professionals who should take into consideration circadian typology, resilience and optimism when developing prevention and health promotion programs. Further research is needed to confirm the relationships between circadian typology and psychological strengths, especially by using longitudinal designs.

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DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

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Table 1. Sociodemographic data according to sex and circadian typology groups.

	Sex					Circadian typology						
	Men		Women			Morning-type		Neither-type		Evening-type		
	n	%	n	%	χ^2	n	%	n	%	n	%	χ^2
Employment status												
Student	460	47.0	411	43.5	2.37	92	21.9	445	46.0	334	62.7	158.43*
Worker	518	53.0	533	56.5		329	78.1	523	54.0	199	37.3	
Marital status												
Single	502	51.3	398	42.2	16.22*	126	29.9	459	47.4	315	59.1	80.66*
Paired	476	48.7	546	57.8		295	70.1	509	52.6	218	40.9	

*$p < 0.001$

Table 2. Results of the 10-item Connor Davidson Resilience Scale (10-item CD-RISC) and the Life Orientation Test-Revised (LOT-R). Descriptive statistics (mean ± standard error) for the total sample, sex and circadian typology groups. F-tests, partial eta-square (η_p^2) and observed power obtained in analysis of covariance for sex and circadian typology groups.

		Sex					Circadian typology					
	Total sample (N = 1922)	Men (n = 978)	Women (n = 944)	F	η_p^2	Observed power	Morning-type (n = 421)	Neither-type (n = 968)	Evening-type (n = 533)	F	η_p^2	Observed power
10-item CD-RISC	29.00 ± 0.14	29.10 ± 0.20	28.89 ± 0.20	3.62	.002	.48	30.90 ± 0.26	29.35 ± 0.19	26.85 ± 0.28	45.89**	.046	1.00
LOT-R	21.58 ± 0.11	21.02 ± 0.15	22.15 ± 0.15	8.31*	.004	.82	23.24 ± 0.21	21.86 ± 0.15	19.75 ± 0.20	37.74**	.038	1.00

*$p < .01$; **$p < .001$.