UV RADIATION AND NEUROTICISM

RADIACIÓN ULTRAVIOLETA Y NEUROTICISMO

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Abstract

Decreased UV radiation is associated with augmented depression, drug use, and domestic violence. Findings entailing folic acid suggest that gender moderates such relationships. The present study was designed to evaluate the relationship between UV radiation and Neuroticism among females and males. Representative consumer panels of three Peruvian cities at decreasing levels of radiation exposure were compared. A 7-item Neuroticism scale was used. A hierarchical regression model revealed that Neuroticism increases with decreased exposure to UV radiation, but the expected radiation x gender interaction failed to materialize. The findings uphold the concept that Neuroticism is responsive to geophysical stimulation. Improvements of mental health can be expected with climate change. The study should be replicated with strengthened methodology.

Key words: UV radiation, Neuroticism, vitamin D, dopamine, folate, Peru.

Resumen

La disminución de radiación UV se asocia a aumentos de la depresión, el uso de drogas, y la violencia doméstica. Hallazgos referidos al ácido fólico sugieren que el género modera estas relaciones. El presente estudio fue diseñado para evaluar la relación entre radiación UV y Neuroticismo entre hombres y mujeres. Se comparó paneles de consumidores representativos de tres ciudades peruanas expuestas a diferentes niveles de radiación UV. Se usó una escala de Neuroticismo de 7 ítems. Un modelo de regresión jerárquica reveló que el Neuroticismo disminuye con la exposición a radiación UV, pero no se

materializó la interacción radiación x género esperada. Los hallazgos apoyan la idea de que el Neuroticismo responde a la estimulación geofísica. Se puede esperar mejorías de la salud mental con el cambio climático. Se debe replicar el estudio con metodología reforzada.

Palabras clave: Radiación UV, neuroticismo, vitamina D, dopamina, folato, Perú.

Introduction

Scores on the Beck Depression Inventory decrease with minutes of sunshine, global radiation, and length of daylight (Molin, Mellerup, Bolwig, Scheike, & Dam, 1996) and light therapy interventions yield effect sizes similar to those in most antidepressant pharmacotherapy trials (Golden, Gaynes, Ekstrom, Hamer, Jacobsen, Suppes, ... & Nemeroff, 2005). Consistent with this evidence, winter or seasonal depression is particularly pronounced at higher latitudes (Magnusson, 2000), where UV photons are scarce. The mediator may be vitamin D, which decays in the absence of UV photons (Engelsen, Brustad, Aksnes, & Lund, 2005). This vitamin, actually a hormone, activates genes relevant to the modulation of brain development and the presence of neuropsychiatric disorders (Harms, Bume, Eyles, & McGrath, 2011). More specifically, vitamin D deficiency alters dopamine-mediated behaviors and the dopamine transporter function (Kesby, Eyles, Bume, & McGrath, 2011); dopamine deficiency is associated with depression (Dunlop & Nemeroff, 2007). Winter depression is not significantly present in Iceland apparently due to its population's intensive consumption of a fish which contains high doses of vitamin D (Magnusson, Axelsson, Karlsson, Oskarson, & Högi, 2000). Considering that vitamin D decreases with distance from the equator, León (2012) attributed the greater use of tobacco, alcohol, and coca leaf observed in southern than northern Peru (León, 1987) to affective disorders associated with diminished levels of vitamin D and predicted greater domestic violence with absolute latitude. His findings in four Peruvian regions confirmed that domestic violence increases with distance from the equator in this country, despite the opposite latitudinal tilts of women's empowerment, education, and household assets (León, 2012a).

Depression, drug use, and domestic violence are conditions related to Neuroticism, one of the Big Five personality factors, defined by volatility and withdrawal (DeYoung, Quilty, & Peterson, 2007). Depression is predicted from Neuroticism (Noteboom, A., Beekman, A.T.F., Vogelzangs, N., & Pennings, B.E.J.H. (2016) and cocaine/heroin users (Terraciano, Löckenhoff, Crum, Bienvenu, & Costa, 2008) and both husbands and wives in violent couples (Kaur & Sokhey, 2011) score very high on Neuroticism. However, the relationship between UV radiation and Neuroticism has not been studied.

Folic acid is another likely mediator. Folate has antidepressant effects, apparently through its actions on the serotonergic system (Brocardo, Budni, Kaster, Santos, & Rodrigues, 2008); UV radiation degrades folate (Borradale & Kimlin, 2012). Greater levels of plasma and red blood cell folate concentrations have been found among women than men, in the south than in the north, and in spring than fall in China (Hao, Ma, Stampfer, Ren, Tian, Tang, et al., 2003). Hao et al.'s evidence (their Table 2) suggests that changes in UV radiation affect folic acid levels to a greater extent among women than men. Greater neuroticism among females than males has been reported in the United States, Canada, Peru, and across countries (e.g., León, Morales, & Vértiz, 2017).

The present study was designed to evaluate whether there is a positive relationship between UV radiation and Neuroticism (Hypothesis 1) and whether gender moderates it (Hypothesis 2).

Method

Study design

The three largest Peruvian cities were targeted. Trujillo (pop. 799,550) is at 805' S and 30 m. above sea level (masl); Lima (pop. 9,866,647), the country's capital, is at 1201' S and 13 masl; and Arequipa (pop. 869,351) is at 16019' S and 2,539 masl. Average temperature is 19.20, 19.70, and 14.70 Celsius, respectively. Daily predictions of UV radiation are always higher for Trujillo than Lima and higher for Lima than Arequipa or similar in these two cities (SENAMHI, 2017). This is so because Arequipa's altitude, augmenting exposure to UV radiation, compensates for its higher absolute latitude; however, due to the associated lower temperature, people in Arequipa expose smaller parts of their skin to UV radiation than people in Lima. Thus, we measured exposure to radiation with a simple scale, assigning 3 points to Trujillo, 2 to Lima, and 1 to Arequipa.

Subjects

The subjects were recruited by CPI, a marketing research agency that frequently consults representative panel groups across Peru. Men and women from 18 to 70 years of age were considered; other inclusion criteria were that the subjects be literate and above the line of poverty. The sample sizes reflected the population sizes: Lima N = 293, Arequipa N = 107 and Trujillo N = 76. The marketing panel sizes used by CPI are calculated to yield a 4.4% margin of error in choices between products or political preferences with a 95.5% confidence interval. Women were majority in each city: Trujillo, 53%, Lima, 55%, and Arequipa, 67%.

Measurements

A questionnaire designed by Michael Minkov asked the respondents to choose between two opposites. "Please describe yourself in terms of the personal characteristics below. Each question consists

of two opposites. Please choose the one that describes you more accurately. If you think that you are somewhere in between these two opposites, please choose the option in the middle." For example: 1. I am usually happy and in a good mood. 2. I am somewhere here, in between these two. 3. I am rarely in a very good mood." To measure neuroticism, seven items with this structure and scored 1, 2, or 3 were used in the present research. The responses scored 3 were "I am rarely in a very good mood"; "I worry a lot and frequently feel nervous"; "I get angry easily"; "When things go wrong, I usually lose hope"; "I am usually timid"; "I can feel happy and sad at the same time"; and "I can like you and dislike you simultaneously". These items resemble items which measure the volatility and withdrawal aspects of Neuroticism (De Young, Quilty, & Peterson, 2007). α-reliability for the sum of item scores was .65. Data on gender, age, education, and income were also analyzed.

Procedure

The questionnaire was administered online and informed consent forms were obtained from all subjects.

Statistical analyses

General linear models and hierarchical regression were utilized. Considering that the .05 p value is too permissive, the significance level for hypothesis testing was set at .005, as recommended by Benjamin, Berger, Johannesson, Nosek, Wagenmakers, Berk, …. and Johnson (2017). Since the Neuroticism scale appeared to be non-normally distributed (Kolmogorov-Smirnov, p = .018), bootstrapping was used throughout the analyses.

Results

Neuroticism correlated significantly with all the variables except education (not shown). A negative correlation was observed between UV radiation level and gender (male = 1, female = 0), which indicates an increasingly diminished presence of women in public life from southern to northern Peru. In a general linear model, Arequipa presented significantly greater neuroticism scores than Lima (p = .000) and Trujillo (p = .000) but the Lima scores were not significantly lower than those of Trujillo (p = .683). Pair comparisons for income yielded differences approaching significance between Lima (Mean = 5.96) and Trujillo (Mean = 4.91, p = .028) but not vis-à-vis Arequipa (Mean = 5.30, p = .193). Participants from Lima (Mean = 34.36) were older than those from Trujillo (Mean = 29.45, p = .004) and tended to be older than those from Arequipa (Mean = 30.52, p = .013). The groups did not differ significantly in education or gender in pair comparisons.

Table 1. Standardized coefficients from hierarchical regression model evaluating the main effects of five variables and a radiation x gender interaction on neuroticism

Predictors	Step 1		Step 2	
	β	p	β	p
UV radiation	-.16	.002	-.24	.204
Age	-.17	.001	-.17	.001
Education	-.01	.883	-.01	.903
Income	-.10	.053	-.10	.051
Gender	.10	.055	-.00	.986
UV radiation x gender			.124	.652
R^2	.103		.103	
R^2 change				.619
(Degrees of freedom)	(389)		(388)	

Testing of the hypotheses used the 3-point UV radiation scale. The results of a hierarchical regression analysis upheld Hypothesis 1: the regressions of neuroticism scores on UV radiation and age were significant, and those of income and gender approached significance (Table 1). Figure 1 depicts mean Neuroticism scores per city and gender.
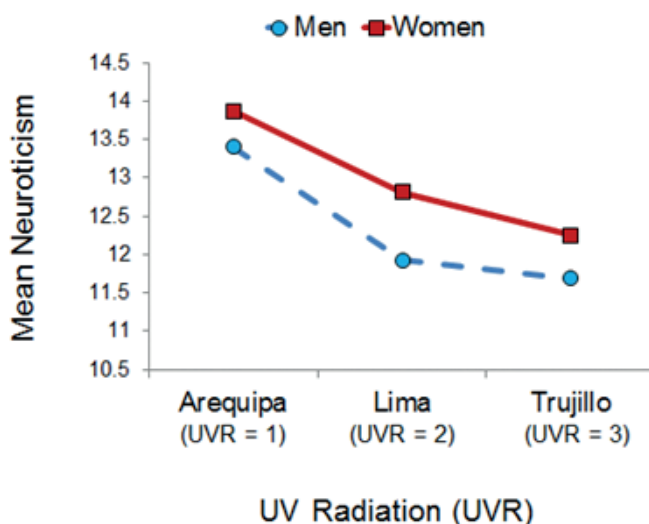

Figure 1. Mean neuroticism scores for men and women in three Peruvian cities at decreasing levels of UV radiation

However, the results did not uphold Hypothesis 2: adding the radiation x gender interaction failed to improve R2 and only introduced noise.

Discussion and conclusion

Testing of the hypotheses was based on a limited number of cases and a Neuroticism scale which exhibited only moderate reliability. Moreover, only three levels of radiation were considered and their range was limited. It is noteworthy that the radiation-Neuroticism hypothesis was confirmed in this context. However, the radiation x gender interaction failed to materialize, albeit its emergence with statistical significance cannot be discarded in a methodologically stronger research. On the other hand, the study findings were consistent with evidence that women present greater Neuroticism than men (e.g., León et al., 2017). Moreover, the increased income with decreased UV radiation observed in the study is consistent with evidence that wealth increases farther from the equator (e.g., León, 2012B; León & Burga León, 2014, 2015).

Deriving causal conclusions from correlational studies will always generate criticism, but in the present situation - considering the demonstrated relationships existing between UV photons, vitamin D, dopamine, and affective processes - UV radiation emerges as a strong likely cause of the orderly increase of Neuroticism with absolute latitude observed. The findings uphold the concept that Neuroticism is responsive to geophysical stimulation and reacts to UV radiation analogously to depression, drug use, and domestic violence. In the absence of credible alternative interpretations, the findings suggest that scientists and practitioners should expect general improvements in mood, personality, and mental health with the increased radiation associated with climate change. Nonetheless, replication of the study with a strengthened methodology is recommended.

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Conflict of interests

The authors do not have conflicts of interest.

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