Open Access Journal of Behavioural Science & Psychology

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Research Article *Volume 1; Issue 1*

Blue Eyes Keep Away the Winter Blues: Is Blue Eye Pigmentation an Evolved Feature to Provide Resilience to Seasonal Affective Disorder?

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Received Date: April 06, 2018; **Published Date:** May 07, 2018

Abstract

In Seasonal Affective Disorder an individual's mood varies with the seasons such that the sufferer is often 'up-beat' in summer, being high spirited and full of energy but, in contrast, depressed in winter with low spirit and lethargy. Today it is considered that much of the population varies in mood with the seasons and that this is associated with latitudes away from the equator (the latitude hypothesis). In order to test this hypothesis we gathered self-reported data from two samples living at two different latitudes (51 N and 35 N). Additionally we examined the relationship between eye colouration and levels of reported mood variability with the seasons. In relation to latitude no significant differences were observed between the samples. With regard to eye colouration, a significant difference was uncovered between blue/light eyed and brown/dark eyed individuals across the samples with the latter self-reporting higher levels of mood variability with the seasons. Results are discussed in terms of the possibility of blue eye colour having evolved to ameliorate the effects of living at latitudes away from the equator with the resultant annual variability in photoperiod.

Keywords: Seasonal affective disorder; Photoperiod; Eye-colour; Adaptation; Latitude

Abbrevations: SAD: Seasonal Affective Disorder; SPAQ: Seasonal Pattern Assessment Questionnaire; GSS: Global Seasonality Scale; SCN: Suprachiasmatic Nucleus

Introduction

Seasonal Affective Disorder (SAD) is a form of recurrent depression which has a seasonal pattern. In the most common form, winter SAD, periods of low mood occur during the winter months, accompanied by an increase in sleepiness, a shift to high starch foods and social withdrawal. In contrast, during the summer, such sufferers are frequently described as up-beat and demonstrate insomnia and high levels of activity [1]. Winter SAD occurs in between 1-10% of the population depending arguably, in part, on the latitude at which the sufferer lives [2]. In the case of summer SAD, low mood occurs during the summer months, although this tends to be an anxious form of depression rather than a lethargic one and there is remission during the winter. Summer SAD is only observed in about 10% of the proportion of winter sufferers. It is necessary for an individual to have a minimum of two ongoing years of symptoms in order to fulfil diagnostic criteria [3].

Citation: Workman L, et al. Blue Eyes Keep Away the Winter Blues: Is Blue Eye Pigmentation an Evolved Feature to Provide Resilience to Seasonal Affective Disorder?. OA J Behavioural Sci Psych 2018, 1(1): 180002.

Individuals may differ in the level of seasonal symptom severity. In addition to full-blown SAD, a large proportion of the population appear to have a lesser form known as subsyndromal SAD [4]. S-SAD is often referred to as 'winter blues' [5]. Today many experts consider that most people demonstrate, up to a point, a degree of mood variability with the seasons, at least for those living at latitudes away from the equator [6,5,7]. This means that SAD and S-SAD can be viewed as one end of a continuum that ranges from, no mood variability between the seasons, to a serious clinical condition which may require hospitalisation for effective treatment.

The Seasonal Pattern Assessment Questionnaire

The Seasonal Pattern Assessment Questionnaire (SPAQ) was developed to estimate the extent to which an individual varies in mood with the seasons [8,1]. The SPAQ is a self-report questionnaire which measures the extent of seasonal changes according to the following areas; weight, sleep, appetite, social activity, and energy. The SPAQ contains a Global Seasonality Scale (GSS) which consists of a score that ranges from 0 (no seasonal change) to 24 (extreme changes in mood and behaviour with the seasons). The proposed cut-off point to diagnose SAD has been established as a GSS score of 11 or higher. A score of between 8-10 suggests S-SAD and even scores a little below this may be taken as evidence of slight, but noticeable, mood changes with the seasons [4]. This has led to the notion of a general population continuum.

Research on the psychometric properties of the SPAQ has demonstrated valid and reliable results. Thompson & Isaacs [9] have shown moderate test-retest reliability (0.37 - 0.72) for SPAQ, with a median reliability of 0.51 for the GSS. The global impairment rating was 0.79. Similarly, a moderate test-retest reliability (r = 0.62) has been reported for the six-items of the GSS scale [10]. Another study has demonstrated a high test-retest (0.67 to 0.80) reliability and a high global impairment rating (0.80), with a median reliability of 0.72 for GSS. A more recent study has also demonstrated good test-retest reliability(r = 0.87) for the GSS scale of the SPAQ [11]. Additionally, the SPAQ shows high sensitivity (94%), specificity (73%), and a moderate predictive value (45%) for winter problems [8]. Moreover, high internal consistency (0.82) has been reported for the GSS. Overall, these studies suggest that the SPAQ yields high estimates of SAD prevalence, and that it is well able to identify mood variability with the seasons [12].

The Latitude Hypothesis of Seasonal Affective Disorder

Present evidence suggests that the further a population lives from the equator the larger the proportion of that population is observed to suffer from SAD and S-SAD [13,14,2,5]. This is believed to be related to the greater seasonal variation in photoperiod increasingly associated with latitudes away from the equator and is known as the 'latitude hypothesis' of Seasonal Affective Disorder. Rosen et al. [2] investigated four progressivley lower latitudes in the United States (Nashua, New York, Montgomery County, and Sarasota) and found that prevelance rates decreased from 9.7% through 4.7% and 6.3% to 1.4% respectively [6]. Despite this finding and the common belief that both S-SAD and SAD increase as we move away from the equator, some studies have failed to find such a relationship. A study conducted at four different latitudes in Turkey failed to uncover a relationship between latitude and GSS scores. Moreover, a study in Japan found the opposite pattern as rates of SAD were nearly three times higher in southern regions than in northern ones [15].

Such mixed findings of the realtionship between latitdue and rates of SAD has led to the suggestion that, rather than variation in photoperiod, other factors may act as a mediator in the relation between SAD prevalence and latitude. Such other factors include socio-cultural [15], genetic, cognitive and environmental [6].

Clearly, the jury is currently out with regard to the latitude hypothesis of Seasonal Affective Disorder.

Eye Colour

Human eye colouration varies from light grey/blue to very dark brown depending on the distribution of melanin pigmentation in the iris. It is well established that the darker the pigmentation of the iris, the greater the degree of absorption of light prior to reaching the retinal cells. In 1995 it became apparent that some retinal cells constitute a non-image-forming visual pathway from eye to suprachiasmatic nucleus (SCN) of the hypothalamus [16]. As the amount of short wavelength (blue and green) light reaching the hypothalamus, via this non-image-forming route, increases so does the release of the hormone cortisol. In contrast, as the amount of light increases, melatonin release decreases. In this way the level of stimulation of the SCN via the non-image-forming visual pathway is thought to be related to the symptoms of SAD. That is, that these neurochemical changes are related to

general mood variation with the season and that people vary in the degree to which variation in photoperiod leads to such seasonal changes [5]. This finding of an indirect relationship between levels of luminosity that reach the retina and levels of SAD raises the question of, will people who have lighter eye colouration demonstrate lower scores on the GSS of the SPAQ?

In the current study we examined both the latitude hypothesis and the relationship between eye pigmentation and scores on the GSS via a non-clinical sample who, it is, anticipated will vary in their mood seasonality as part of a normal distribution. The two selected latitudes covered southern Wales and northern Cyprus.

Hypothesis 1 (H1): Levels of SAD will be higher in South Wales than in Northern Cyprus

Hypothesis 2 (H2): Participants falling into the dark/brown eye grouping will demonstrate higher levels of SAD as measured by the SPAQ when compared with participants falling into the light/blue eye grouping.

Method

Design

A within-subjects correlational design was utilized for this study to investigate:
1) the relationship between latitude and seasonal affective disorder. This was done by correlating participants' GSS scores and country they currently live in.
2) the relationship between eye colour and Seasonal Affective Disorder. Participants' GSS scores were correlated with their eye colour.

Participants

A total of 175 undergraduate and graduate students (89 females; 86 male) were recruited from the University of South Wales (South Wales, latitude 51 N) and Girne American University (North Cyprus, latitude 35 N) as participants for this research study. Of these participants, 76 (43.4%) were from South Wales, and 99 (56.6%) were from North Cyprus. The mean age of participants was 24.02 years (SD=7.9).

Materials

Information sheets and debriefing forms were given to participants as hard copies at the beginning and following the experiment respectively.

All participants were asked to complete a computerized version of the Martin Schultz Scale (see below) and the SPAQ. These instruments have proven to be reliable assessments of eye colour and level of seasonality. In addition to the information obtained from the above materials, students were asked to provide demographic information about themselves (i.e., age, gender). A software programme, E-prime (version 2.01) was utilized to construct the questions and record participant responses.

Martin-Schultz Scale

The Martin-Schultz Scale, developed by Rudolf Martin and Bruno K. Schultz, is a commonly used eye colour scale, used particularly in physical anthropology, to demonstrate accurate eye colour of an individual. The scale comprises 16 colours, but allows for broad classification into dark/brown and light/blue categories [17].

Procedure

In the initial sessions, participants were asked for their consent to participate in the research project, which was conducted in a private study room adjoining to the university libraries. After providing instructions to the participants via the information sheet, the study began. Participants understood that their participation was voluntary and confidentiality would be maintained; if at any time they felt uncomfortable they could withdraw from the study without penalty. After participants were seated in front of a laptop computer, they were instructed to complete the following sections; the demographic information portion, Martin Schultz Scale and SPAQ.

After completion of the demographic information portion, participants were asked to enter a number from 1 to 16 which correspond to their eye colour by looking at the Martin-Schultz Scale. Following this, participants were instructed to complete the SPAQ section which involved six questions in assessing whether their mood, weight, appetite, sleep and social activity changed according to the season. Upon completion of the task, participants received a debrief form and were given an opportunity to discuss any issues that they may have had, and the researcher explained the purpose of the research. It was ensured that the application of this procedure was identical between the two countries. As psychology is taught through the medium of English at the University of South Wales and at Girne American University all instructions where provided in English.

Ethics

This study was approved by the Faculty of Life Sciences and Education ethics panel of the University of South Wales and by the equivalent ethics personal in Psychology at Girne American University.

Results

With regard to hypothesis 1, an independent samples t-test was run to determine the differences in levels of GSS scores in South Wales and North Cyprus. Variables were normally distributed as assessed by Shapiro Wilks test (p>0,05). Homogeneity of variances was not violated as assessed by Levenes (F = .919, p >0,05). However, the result did not show a statistically significant difference for GSS scores between the two countries (t (173)=0.35 p>0,05, 95% CI for mean difference -1.46 to 1.02). Although not significant, the mean GSS score for North Cyprus was slightly higher (M=11.06 SD=3.94) than the mean score for South Wales (M = 8.66, SD = 4.02) (Figure 1).

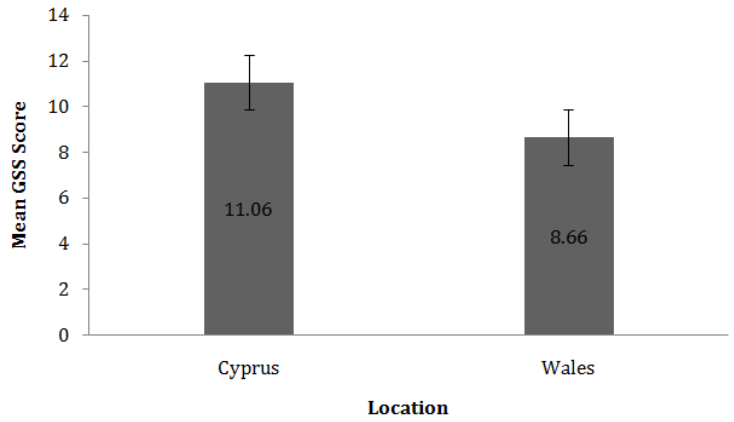

Figure 1: Mean GSS scores and SEM for South Wales and North Cyprus

With regard to hypothesis 2**,** a significant difference between the GSS scores for blue eyes and dark eyes was uncovered (t (173) = 6,05, p< 0,01, 95% CI for mean difference -4.674 to -2.374). Participants with dark eyes (M = 12.31 SD= 4.004) scored higher on the GSS than participants with blue eyes (M = 8.79 SD = 3.287). The effect size for the analyses was large (d=0.96) (Figure 2).

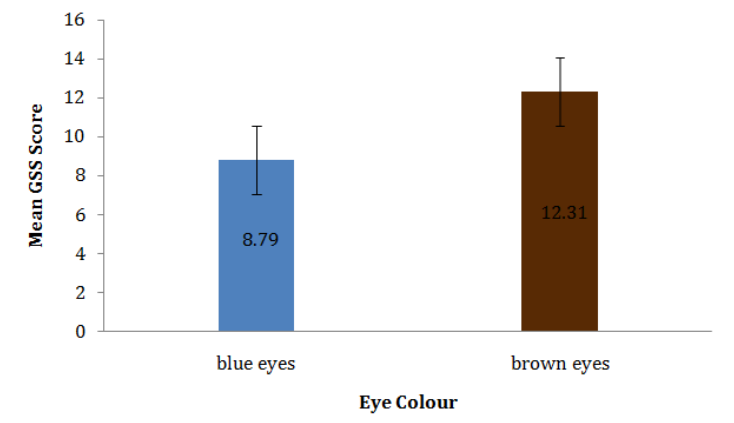

Figure 2: Mean GSS scores and SEM for blue/light and brown/dark eyed participants

Discussion

Considering the latitude hypothesis, hypothesis 1 predicted that participants from South Wales would produce higher GSS scores than those from North Cyprus. Contrary to this prediction, the results revealed little to no difference in such scores between North Cyprus and South Wales. Hence, the association between SAD and latitude was not supported in the current study. There appear to be two possible explanations for this finding. Either there is no straightforward relationship between latitude and seasonal variation in mood in our sample, or this relationship went unidentified due to other variables or methodological limitations (see later).

Although a number of studies support the latitude hypothesis [14,15,2,5] there are also a number of studies which suggest latitude is not a primary factor in determining levels of reported SAD [18,15]. How might we resolve this? One possibility is that latitude and the photoperiod variability that this leads to does affect levels of SAD but only for a subsection of the population. İmai et al. [15] found that, for adolescents, there is no observed difference between different latitudes, whereas for older individuals there is a significant effect of latitude in the predicted direction. This might be taken to suggest that younger people have more resiliance to SAD than older ones. In the case of both of our samples the vast majority were aged between 18-25 (150 out of 175). This would have placed them within, or closser to, the younger sample of İmai et al.'s study. Hence, it is conceivable that, had we made use of an older sample, we may then have uncovered a significant latitude effect. It is also conceivable that other differences between the two samples (socio-cultural, genetic or cognitive diferences between populations) served to modulate the effects of latitude. Examination of such factors is beyond the scope of the present study.

Considering the second hypothesis, the finding that those in the sample with blue eye colouration have significantly lower GSS scores on the SPAQ might be taken to suggest blue-eyed individuals have a degree of resilience to SAD. In fact not only did brown eyed participants have a significantly higher score than blue eyed ones, but their mean score (12.31) was actually within the range for diagnosis as having Seasonal Affective Disorder. In contrast, the blue eyed participants in the sample were, on average, well below this cut off point, (although, interestingly, their mean score was just within the S-SAD range at 8.79). How might we explain this clear and significant difference?

Currently, it is widely believed that blue eye colouration, arose via a genetic founder effect involving a point mutation relatively recently in human evolution, around 10,000 years ago [19,20]. Following this founder effect, two main hypotheses have been proposed to explain why this mutation was been maintained within European populations. First, we have the concept of Darwinian sexual selection. That is, a feature is maintained within a population due to being attractive to the opposite sex (or in as much as it helps in the competition for mates) [19,21] Second, it has also been proposed that the blue eye mutation is maintained in populations, particularly in northern Europe, as a side-effect of the mutation which reduced skin melatonin pigmentation in order to maximize vitamin D conversion in low levels of ultraviolet light radiation. Both of these hypotheses are supported by the fact that, even today, frequencies of blue eye colouration reach their highest proportions in the most northerly latitudes of Europe and that this proportion diminishes as we move south [22]. The observation that brown eyed individuals in our sample scored, on average, within the SAD classification range on the GSS, whereas the blue eyed sample recorded significantly lower scores may provides us with a third hypothesis. It is tentatively suggested that, rather than the blue eye pigmentation mutation arising via sexual selection to boost mating opportunities or as part of an adaptation to boost vitamin D production, it may have arisen as an anti-SAD adaptation due to selective pressures experienced once ancestral hominins moved to latitudes away from the equator (and experienced the resultant shortened winter photoperiod).

Clearly, in order for this SAD resilience to form a selective force which maintained blue eye colouration within European populations, high levels of mood seasonality would have to have led to lower reproductive success rates in northerly latitudes for brown eyed individuals. Is it possible that SAD can be so debilitating as to reduce offspring production at these latitudes? Norman Rosenthal, who originally coined the term SAD, has described how, for severe sufferers of the condition, social withdrawal is commonly observed. Moreover, some such cases report suicidal levels of depression during the winter months [5]. Given these observations, then it is feasible that resistance to SAD may have had a notable selective advantage for northern European populations. It should also be noted that a trait can evolve as a result of more than

one selective force [23,20]. This means that all three selective forces might have acted together to maintain blue eye colouration within northern European populations.

Methodological limitations

Although the GSS of the SPAQ is widely used and demonstrates high sensitivity and reasonably good reliability, it is not without its critics. Spoont et al. [24] have questionned how well the SPAQ distinquishes between S-SAD and SAD. They have also pointed out that, while the SPAQ is a useful tool for determining rates of S-SAD and SAD, it only provides broad psychometric data for the individual. With regard to the first point, Mersch et al. [12] following exmainaition of how the SPAQ has been used, suggest that it does distinguish well between S-SAD and SAD [15]. With regard to the second criticism, it is likely that the SPAQ has limited utility when considering individual mood problems. Given, however, that the aim of the current study was to compare groups of individuals on two criteria, it might be suggested that it is entirely appropriate for this purpose.

Another limitation was the age range of the two samples used in this study. Given that previous research by İmai et al. [15] suggests seasonal mood variability is higher in older age groups, our sample may well have been limited in this respect. Further studies should consider expanding the age range of participants. The fact that we did not make use of a clinical sample might also be considered a limitation of this study. We should bear in mind, however, that a clinical sample would most likely have demonstrated a 'ceiling effect'. That is, variability between participants would have been very low, due to all receiving a diagnosis of SAD. Moreover, the aim of the current study was to compare samples from the general population in order to determine whether the variables of latitude or eye colour had main effects.

Conclusion

Two samples were compared on a measure of self-report seasonal mood variation from two different latitudes (SouthWales, 51 N and North Cyprus, 35 N) in order to test the latitude hypothesis of Seasonal Affective Disorder. No significant differences were observed between the samples. Hence, the latitude hypothesis was not supported in this study. In contrast, a significant difference was uncovered between broadly blue/light eyed people and broadly brown/dark eyed individuals across the samples. It is tentativley suggested that blue eye colouration may have evolved, in part, to reduce seasonal mood variability at northern latitudes. Future studies of Seasonal Affective Disorder and mood variability in general would benefit from making use of an expanded age-range in their samples.

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