CORNERSTONE
MINNESOTA STATE UNIVERSITY MANKATO

Journal of Undergraduate Research at Minnesota State University, Mankato

Volume 7 Article 12

2007

The Impact of Weather Conditions on Mood Variability in Geographically Relocated Versus Non-Relocated Individuals

Jamie M. Scott
Minnesota State University, Mankato

Student Agreement:
I am submitting my research article to be published in the JUR (The Journal of Undergraduate Research at Minnesota State University, Mankato), an electronic journal of the Minnesota State University Undergraduate Research Center.

I/We certify have followed the accepted standards of scientific, creative, and academic honesty and ethics.

I understand that my article submission will be blind-reviewed by faculty reviewers who will recommend acceptance for publication; acceptance with revisions; or reject for publication.

I understand that as author, I retain the right to present any part of the research in any form in other publications.

The JUR has the right to reproduce and reprint published submissions for instructional or promotional purposes.

For complete details, see *Journal of Undergraduate Research at Minnesota State University, Mankato policies page.*

Mentor Agreement:
I have reviewed the submission, and I support its inclusion in the JUR (The Journal of Undergraduate Research at Minnesota State University, Mankato). I understand that I will be acknowledged as the faculty mentor for the student author(s). To the best of my knowledge, the student has followed the accepted standards of scientific, creative, and academic honesty and ethics.

The Impact of Weather Conditions on Mood Variability in Geographically Relocated Versus Non-Relocated Individuals

Jamie M. Scott

Minnesota State University, Mankato

Abstract

A void exists in the literature in regards to how identical weather conditions impact individuals from different geographic locations. It is believed relocated individuals are more susceptible to fluctuations in mood stemming from novel weather conditions than indigenous individuals. The sample consisted of 70 life-long Minnesota residents and 25 individuals who have spent minimum of one year living outside of Minnesota. Participants completed a mood self-report measure online for four consecutive weeks to determine positive and negative affect levels. Data was then matched with corresponding weather data for the same time period. No support was found for the hypothesis. However, sunshine was identified as the crucial factor for mood adjustment.

The Impact of Weather Conditions on Mood Variability in Geographically Relocated Versus Non-Relocated Individuals

Weather has long been regarded to influence the mundane mood of the individual. A pervasive belief exists amongst the population that individual‟s moods are heightened by warm and sunny days, days that are casually referred to as „nice days,‟ whereas moods are lowered by cold and cloudy days, conditions that are generically classified as a „poor weather day.‟ However, studies on the relationship between weather and mood are limited, difficult to interpret, susceptible to confounding variables, and of mixed result. Perhaps the reluctance on the part of researchers to examine the weather-mood association stems from the inadequate measurability described by Persinger (1980) in which people report their mood self-evaluations with descriptors such as “I feel better” or “I feel worse,” and the difficulty this presents for analysis. Nonetheless, self-report currently remains the most common method for measuring mood and it has been utilized for the majority of studies investigating the weather-mood relationship.

Weather-Behavior Association

Weather has been shown to impact everyday behavior. Behavioral changes result from physical characteristics of the environment stimulating the organism, often without the organism‟s awareness. Evidence indicates a pattern of alternating sympathetic and parasympathetic nervous system stimulation by contrasting meteorological conditions, with each system‟s incitement, in turn, causing secondary behavioral changes (Persinger, 1980). For example, sympathetic activation arises from a combination of increased barometric pressure, lower temperatures, and elevated humidity. Such a meteorological arrangement precipitates vascular constriction in the skin, a development which modulates conscious symptoms including

ambulation, migraine headaches, and diuretic activity (Persinger, 1980). Meanwhile, parasympathetic activation occurs in response to falling barometric pressure, higher temperatures, and high humidity, in addition to instigating water retentive and arthritic consequences. It is doubtful that the individual would attribute these somatic and behavioral consequences to vascular dilations and constrictions, and is subsequently more likely to ascribe credit to more salient and immediate stimuli. However, there is a clear association between peripheral circulation and environmental conditions, particularly temperature (Persinger, 1980).

Weather-Mood Association

Past research has described mood variations chiefly as a result of individual weather variables rather than in terms of a more holistic description, such as „nice days‟ or „poor days,‟ an arrangement most likely due to the subjective nature of such holistic classifications. The utilization of specific weather data, such as numerical barometric pressure readings and precipitation amounts, consequently provides the researcher with a numerical objectivity otherwise unobtainable through the use of broad subjective evaluations of the weather. Nevertheless, holistic classifications may provide greater ecological validity for the average individual being as they are a part of the common vernacular and thus may be more meaningful.

Experimental evidence has indicated that positive mood is associated with increased frequencies of helping behavior (Batson, 1979). Cunningham (1979), characterizing the act of helping as a behavioral manifestation of positive affect, found that temperature and helping behavior are positively correlated in the winter and negatively correlated in the summer. However, a temperature-helping curvilinear relationship was significantly stronger than a linear equation. In addition, higher levels of sunshine were associated with increased helping behavior

across both seasons. Furthermore, participant mood self-reports indicated a significant relationship between positive affect and levels of sunshine and temperature.

Howarth and Hoffman (1984) elected to focus on changes in mood dimensions rather than dichotomous good mood-bad mood ratings. Humidity was the sole predictor of sleepiness, with elevated humidity readings associated with increased ratings of sleepiness, a result consistent with two other studies (Goldstein, 1972; Sanders & Brizzolara, 1982) reporting that activity and humidity are inversely related. Humidity was additionally the sole predictor of potency, a measure of self-confidence and self-assurance. Concentration was positively impacted by amount of sunshine and temperature, yet negatively impacted by humidity. As sunshine amounts increased so did optimism, whereas skepticism decreased. Skepticism was additionally affected by precipitation and changes in barometric pressure.

Three separate studies provide further evidence for the effect of weather upon general mood. Analysis by Schwarz and Clore (1983) showed subjects queried on sunny days reported greater momentary happiness and life satisfaction than subjects asked on rainy days. However, no further examination or discussion was undertaken by the researchers to determine whether the precipitation or the accompanying reduced sunshine was responsible for the diminished happiness and life satisfaction ratings. In a study of mood incongruent recall, exposure to clear and cloudy weather was successfully utilized as a means of producing happy and sad moods (Parrott & Sabini, 1990). Finally, humidity was demonstrated to have an inverse relation with elation (Sanders & Brizzolara, 1982), a mood variable which can be assumed to highly correlate with the broader „good mood‟ rating.

Weather has clearly demonstrated an ability to elicit behavioral and affective changes in the population. However, the literature is not without contradictory evidence as it relates to

weather and mood. Weather was amongst a wide range of mundane phenomena examined as part of an investigation of daily life events and their relation to self-reported mood (Clark & Watson, 1988). A standardized structure of two independent mood factors, comprehensive PA (positive affect) and NA (negative affect) were constructed from the daily self-ratings of 57 mood terms; such an action enabled the juxtaposition of weather-induced mood levels with mood ratings from other mundane events. Participants were additionally asked to record any problems, complaints, or unusual conditions they experienced for that day. Despite numerous rain and temperature complaints by participants, extensive analysis failed to reveal any significant relationship linking changes in mood with variations in the weather.

The largest examination to date of the mood-weather hypothesis (Watson, 2000) consisted of 478 participants completing a prodigious number of daily assessments (20,818 total observations). Using the self-report Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988), it appeared that no significant correlation was found between mood and any of the assessed weather variables (barometric pressure, precipitation, sunshine, and temperature). However, in one of a multitude of analyses, Watson determined that higher scores were associated with completely sunny days, an arrangement implying that sunshine primarily impacts the intensity of an already existing mood. Nevertheless, it should be emphasized that despite this sole significant finding, all other correlations in the same series of analyses were marginal at best. This appears to provide some evidence contrary to the societal belief that weather plays a major role in everyday mood.

In allowing for the circumvention of a direct link between mood and weather, Watson (2000) proffered an explanation for people‟s omnipresent overestimation of weather‟s ability to influence our moods. It is, per Watson, another example of an illusory correlation, a

phenomenon which consists of an individual seeing a relationship when, in fact, one does not exist. In the case of the mood-weather question, people will selectively notice and recall instances of it being sunny outside which coincide with being happy or instances of it being rainy and cloudy and they are unhappy. Examples which are contrary to these situations, (i.e., being sad on a sunny day), are quickly forgotten and the weather is dismissed as an inappropriate explanation for their dour mood. This biased perception and recall serve to reinforce their already erroneous beliefs. It should not be overlooked, however, that this view still allows for weather to impact mood levels, albeit through preexisting individual biases.

Characteristics of Mood Variability

Stating that weather conditions can freely disrupt typical affect levels implies that mood variability is a passive, unstable, and unreliable aspect of an individual‟s personality. A further implication is that we would continuously find ourselves a victim of occasion as mundane happenstance would trigger uncontrollable emotional instabilities. However, one must only reference their subjective experiences to conclude such an acquiescent system is inherently false. Mood variability was seen as a distinct personality trait by early personality theorists (Allport, 1937; Guilford, 1959). This viewpoint of temporally consistent mood variability within individuals is supported by McConville and Cooper (1997) who utilized two sources of longitudinal mood data for analysis. Test-retest correlations clearly demonstrated a temporal consistency in mood variability within individuals, particularly in regards to negative affect where approximately 60% was shared variance.

Penner, Shiffman, Paty, and Fritzsche (1994) broadened the scope of their examination of individual differences in mood variability to assess not only the stability of mood variability over time but across situations as well. Echoing the results of McConville and Cooper (1997), Penner

et al. (1994) discovered a high degree of temporal stability when utilizing an odd-even day comparison. Correlation values for each of the 11 scale items were above .60, with the total average item correlation being .76 (N = 54). Correlations values regarding mood variability across situations (.51) were lower than those pertaining to temporal stability; nonetheless, they are high enough to suggest a modest degree of intrapersonal stability in mood variability. It should not be surprising that the situational correlations were lower, as even the most ardent proponents for consistent trait associated behavior across situations (e.g., Epstein, 1984) will acknowledge that people are responsive to changes in the environment, a theoretical issue which forms the crux of the dispositional versus situational debate and the importance of each upon social behavior. It is thus unlikely for any trait, including mood variability, to be completely unaffected by situational stimuli. This reciprocal interaction of disposition and situation allows for a bilateral structure of mood variability, manifested in Penner et al. (1994), as both a stable trait (conspicuous by a strong odd-even day correlation) and as domain specific (evidenced by weaker correlations across situations).

Seasonal Influences on Mood

A key variable of the current study, weather, unequivocally falls on the situational end of the disposition-situation continuum, thus raising expectations of identifying atypical fluctuations in mood variability in response to selective natural environmental conditions. This atypical break down in normal mood regulation may be best exemplified by seasonal affective disorder. While the specific criteria necessary for seasonal affective disorder (SAD) diagnosis may be obtained from the DSM-IV (APA, 1994), the essential feature of SAD is the regularly recurring experiencing of affective episodes (depression, hypomania, mania) which coincide with certain seasons. The onset of a Major Depressive Episode characteristically corresponds with the fall or

winter months, and its development is attributed to the individual‟s involuntary physiological and psychological responses to changes in climate and ambient lighting which accompany the season‟s commencement in higher or lower latitudes (Rosenthal & Wehr, 1987). As an illustration, those clinically diagnosed with SAD have reported deterioration in mood resulting from seemingly benign weather conditions; for example, a stretch of predominantly cloudy weather. Such weakened mood regulation demonstrates the natural environment‟s potential lethality to standard automatic functioning in mood regulation; particularly to those at the extremities of the mood regulation continuum (e.g., clinically diagnosed bipolar disorders, seasonal affective disorder, or other depressive disorders).

The majority of the general population does not suffer from clinically diagnosed SAD, however, and as such Ennis and McConville (2004) excluded any such individuals from their examination of the covariation between mood variability and seasonality. Seasonality has been defined as the degree to which mood, energy, sleep, food preferences, appetite, or the desire for socialization are altered in response to seasonal changes (Sher, Goldman, Ozaki, Rosenthal, 1999). Seasonality is a dimension in which symptoms generally exist on a continuum rather than as qualitatively discrete entities, ranging from very mild seasonal changes to extreme mood and behavioral responses with the seasons (Sher, 2001). Measurement tools used by Ennis and McConville (2004) consisted of the Global Seasonality Score of the Seasonal Pattern Assessment Questionaire (SPAQ; Rosenthal, Genhart, Sack, Skwerer, & Wehr, 1987) which measures intensity of seasonal variations in mood and behavior, and the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) which measures the two underlying factors of mood, positive and negative affects. Measurements were recorded for a two-week period. Seasonality scores were found to be significantly positively correlated with overall mood variability, as well

as negative and positive affect variability. These correlations support the suggestion that disturbances in mood are the principal psychological component of seasonality, and that seasonality, much like SAD, influences typical mood regulation.

Mechanisms of Mood Regulation

It is important to examine the domain of mood regulation and its operating principles considering the influence which external environmental entities such as seasons and specific weather elements have upon its functioning. Larsen‟s (2000) mood regulation model operates under the assumption that people are motivated to create and maintain a generally positive or pleasant subjective state and minimize experiences of negative affect. Larsen based his model of mood regulation upon control theory concepts which imply that people maintain some desired affective state (default point) and this preferred point is regularly compared to their current affect state. Regulatory mechanisms are applied whenever discrepancies arise in order to eliminate any emotional dissonance. Mood regulation may therefore be conceptualized as a succession of distinct yet collective control techniques. This model is predicated upon self-regulation of mood, a conceptualization which, in any abridged description, implies effortful processes. However, Larsen pointed out that automatic processes also play a part in mood regulation. These automatic responses to environmental stimuli may affect a diverse array of subjective, motor and expressive behavior, and physiological processes, an outcome which reiterates Persinger‟s (1980) ascertainment of autonomic nervous system activation in response to external stimuli.

Larsen‟s model of mood regulation is similar to the mood repair hypothesis (Clark & Isen, 1982). Like Larsen, the mood repair hypothesis presupposes a preference by the individual for good over bad moods, and that automatic and controlled processes jointly contribute to regulation efforts. Notwithstanding the role which the automatic system enacts upon the

regulation process, Morris and Reilly (1987) emphasize the influential role played by cognitive processes in forming emotional reactions. In fact, there is a general consensus by the multitude of mood regulation hypotheses that controlled processes and not those which are automatic account for the majority of self-regulation. However, the exact specifications of mood regulation‟s manner of functioning should not obscure the evidence of mood regulation plasticity. Regardless of its precise nature, it is possible to conceptualize controlled cognitive processes, supplemented by automatic transpirations, as receptors attuned to diverse environmental determinants and part of the regulatory machinery.

As indicated in a review of the literature, meteorological-related constructs, whether it be individual weather variables such as sunshine or temperature, or more comprehensive phenomena such as seasons or climate, do impact mood. Weather‟s impact upon mood variability can theoretically be conducted through automatic circuits (Larsen, 2000) or it may be percipient via one of two conscious routes: cognitively-controlled emotional reactions (Morris & Reilly, 1987) or an illusory relationship (Watson, 2000). However, speculation regarding the precise mechanism of action is beyond the scope of this study.

Geographic Considerations

Given the current prevalence of geographic relocation in today‟s society, the effect which novel weather patterns may have on the geographically transplanted individual is of interest. In spite of the aforementioned studies pertaining to the weather-mood relationship, a void exists in the literature regarding how identical weather conditions may impact affect of individuals who have spent a significant time period in differing geographic and climatic locations. It would seem reasonable to suggest that individuals who spend a significant period of time residing in separate and distinctive localities will exhibit some form of incongruous response to identical

weather conditions. Conjecture would further imply that any locale of residence for any notable length of time would affect the resident in some way, even if only to mildly change their opinion regarding what does and does not constitute pleasant or unpleasant weather. For example, imagine two individuals relocate to a specific location. The first individual arrives from a warmer, southern latitude whereas the second hails from a colder, northern latitude. Temperatures which feel warm to the northern climate émigré and, therefore, which evoke a positive subjective reaction may at the same time be interpreted by the southern climate émigré as cold and disagreeable. It is therefore plausible that differences in emotional reactivity, which are associated with the individual‟s geographically-located history, may manifest themselves through differing levels of positive and negative affects when responding to identical weather conditions.

Most geographic locations experience different seasonal weather patterns than Minnesota. These distinct seasonal patterns may condition the individual‟s temperament to a location‟s specific seasonality, much like the aforementioned illustration. Reid, Towell, and Golding (2000) documented an association between seasonality and heightened responsiveness to external “zeitgebers,” or environmental agents or events, of which physical light constitutes one. It is suggested, being as elevated mood variability is associated with seasonality (Ennis & McConville, 2004), that environmental zeitgebers will subsequently display a substantial influence upon emotional reactivity. Moreover, these zeitgebers, which may be both physical and social in nature, tend to conjugate with assorted behavioral, physiological, and psychological human rhythms (McGrath, Kelly, & Machatka, 1984). Therefore, whether relocating to Minnesota for the initial time or merely returning, the region‟s unique seasonal weather pattern should manifest itself differently between indigenous and nonindigenous residents due, in part, to

the entrainment of previously experienced environmental stimuli. One manner in which this variance may be demonstrated is in the quantity of mood fluctuation for individuals relocated to an area of weather and seasonality dissimilar to their prior geographic location.

It is hypothesized that geographically-relocated individuals will experience heightened negative affect levels in response to weather conditions associated with „bad weather days‟ than will individuals indigenous solely to Minnesota. Furthermore, it is hypothesized that geographically-relocated individuals will experience greater positive affect levels in response to „good weather days.‟ Stated comprehensively, it is hypothesized that geographically-relocated individuals will display greater mood variability attributable to weather conditions.

Method

Participants

Study participants consisted of Introductory to Psychology students at a 14,000 student Midwestern university (69 females and 26 males, ages 18 - 36), and were recruited via Experimentrak. Final data analysis consisted of 1918 total daily surveys from 95 participants (70 Minnesotan and 25 Non-Minnesotan conditions), an average of approximately 20 responses per participant.

Materials

The daily survey consisted of the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988), utilized to measure the two dependent variables, positive and negative affect, and four questions aimed at measuring confounding variables which may potentially influence the participant‟s mood for that particular day (e.g., how much time they spent outside; their activity level; did they tan at a tanning booth; their opinion of the day‟s weather).

The PANAS is a reliable and valid measure of positive and negative affect. Internal consistency of the scale was assessed utilizing Cronbach‟s coefficient alpha, with alpha reliabilities for the temporal instructions used in the present study (participants were asked to report how they felt for that day) sufficiently high (positive affect, a = 0.9; negative affect, a = 0.87). In addition, the scale adequately discriminated between positive and negative affect, evidenced by its -.12 scale inter-correlation value, indicating quasi-independence. Finally, scale validity was demonstrated via high factorial convergent correlations (.95 and .93) and low factorial divergent correlations (-.02 and -.11; Watson et al., 1988).

Weather data during the time period concurrent with daily survey collection was obtained through the National Oceanic & Atmospheric Administration (NOAA) website. Meteorological variables measured each day included temperature, precipitation, dew point, barometric pressure, and sunshine amount. Only measurements of these variables recorded between 0600 and 2400 hours were included for calculations of daily weather. It was believed that weather from between 0000 and 0600 hours would generally not be experienced by an overwhelming percentage of participants.

Sky condition data obtained from NOAA - utilized as a measure of sunshine levels - was qualitative in nature, with the following five descriptors used (from least amount of sunshine to the greatest): overcast, mostly cloudy, partly cloudy, a few clouds, and fair. A quantitative rating scale was thus created, ranging from overcast sky conditions being represented by a 0 and fair sky conditions represented with a 4 to denote higher sunshine amounts. Hourly sky conditions ratings from between 0600 - 2400 hours were then averaged to determine the day‟s definitive sky condition and, subsequently, sunshine level. For example, if the first half of a given day saw

overcast conditions and then were replaced by fair skies during the second half, a sunshine rating of 2 would be assigned.

The independent variables „high temperature‟ and „sunshine amount‟ were utilized in order to classify days into such blanket categories as „good weather days‟ and „bad weather days.‟ First, „good weather days‟ required a high temperature recording equal to or above the mean high temperature for that particular calendar date as well as a sunshine rating of 3 or above (indicating sky conditions were predominantly sunny). Secondly, „bad weather days‟ required just the opposite, a high temperature below the mean high temperature for that calendar date and a sunshine rating below 3. Finally, days which experienced high temperatures above the mean yet below a 3 sunshine rating, and vice versa, were termed as „indeterminate days,‟ and it was anticipated that these days would serve as a neutral baseline. That is, it was expected that participant‟s affect levels - both Minnesota and Non-Minnesota conditions - would be intermediate in relation to affect levels on good and bad weather days. The decision to not use the sunshine scale‟s midpoint rating of 2 to partition sunshine amounts for the good and bad weather day categories, and rather to use a 3 rating, reflects the distinct contrast between the 2 and 3 sunshine ratings. A rating of 2, which corresponds with NOAA‟s sky condition description of „partly cloudy,‟ implies the possibility of substantial time periods of curtailed sunlight, whereas a 3 rating, „a few clouds,‟ connotes a regular abundance of sunshine.

Procedure

All procedural steps were conducted online. Upon volunteering to participate, students were sent an informed consent form in addition to a unique identification number which served two purposes: one, as a means of ensuring the confidentiality of responses and, two, to enable the linking of all completed surveys to the appropriate participant. An online demographic survey

was completed at the commencement of their participation. Participants then completed the online daily survey containing the mood self-report scale once daily for 28 consecutive days.

Assignment to the respective geographic condition was based upon participant‟s past residency. Those assigned to the non-Minnesota condition required having spent a minimum of one year‟s residency outside of Minnesota at some point in their life, whereas those assigned to the Minnesota condition reported via the demographic survey having lived instate their entire lives.

While an initial total of 148 students enlisted in the study, it was determined that certain criteria needed to be met in order to include their data in the analysis. First, the daily survey needed to be submitted after noon on any given day for it to be included. It was felt that survey completion before this time failed to allow the participant an adequate opportunity to experience that day‟s weather. Second, the participant needed to complete a minimum of 14 out of the possible 28 surveys (50%). The 50% minimal reply requirement was deemed an important feature to ensure that random, isolated surveys from uninterested participants did not unduly influence the survey data aggregate. That is, all analyzed surveys were a part of a more comprehensive survey portfolio, ranging from 14 to 28 daily survey responses, which fostered a more holistic construction of the participant‟s mood variations over the course of the study.

Results

Results did not support any of the study‟s hypotheses. Two-tailed *t*-tests were employed to examine differences between geographic conditions. The Minnesota and non-Minnesota conditions, respectively, reported invariable amounts of positive affect in response to good weather days $t(343) = -.3$, $p > .05$, as well as equal amounts of negative affect in response to bad weather days $t(428) = .108$, $p > .05$. Therefore, the hypothesis that a greater degree of mood

variability would occur in individuals relocated to Minnesota, (i.e., elevated amounts of PA on good days and NA on bad days), was not supported.

Supplemental analyses were conducted to test additional hypotheses that were developed during the course of the study. Several significant results were found. For example, positive and negative affect scores were analyzed using a 2 (geographic condition: Minnesota vs. Non-Minnesota) X 3 (day‟s weather classification: good vs. indeterminate vs. bad) between-subjects ANOVA. There was a significant main effect in regards to negative affect and weather classification, $F(2, 1917) = 5.531$, $p < .01$. Individuals reported experiencing higher levels of negative affect on bad weather days ($M = 17.02$, $SD = 7.322$) than on indeterminate weather days ($M = 15.72$, $SD = 6.290$) and on good days ($M = 16.38$, $SD = 6.722$). Further analysis was conducted through *a priori* contrast tests. Significant findings for negative affect resulted when all bad weather days ($n = 754$) were compared to all good and indeterminate weather days ($n = 1164$), $t(820) = -3.472$, $p = .001$. The Tukey *post hoc* test revealed that the significant difference in negative affect resided specifically between indeterminate and bad weather days ($p = .005$), whereas differences between good weather days and each bad and indeterminate weather days ($p > .167$) were non-significant. Finally, individuals in the Minnesota condition reported significantly greater negative affect on good weather days ($M = 16.66$, $SD = 7.052$) than did those in the non-Minnesota condition ($M = 15.64$, $SD = 5.718$), $t(447) = 2.027$, $p < .05$.

Diminished amounts of sunshine were found to be a causal determinant for manifesting negative affect as a significant main effect was seen for negative affect and sunshine amount, $F(1, 1917) = 5.382$, $p < .05$. Subjects reported heightened negative affect on days whose sunshine rating was below 3 ($M = 16.79$, $SD = 7.131$) than on days categorized with an above 3 sunshine rating ($M = 16.16$, $SD = 6.610$). Furthermore, non-Minnesota participants experienced

greater negative affect on days with a below 3 sunshine rating (M = 16.69, SD = 6.203) than on days with an above 3 sunshine rating (M = 15.46, SD = 5.665); this finding was significant $t(519) = 2.366$, $p < .05$. This trend was not significant for Minnesota categorized participants, nor were any interaction effects found.

Gender differences in mood reports were also observed. A significant main effect was seen in regards to positive affect and gender, $F(1, 1917) = 27.678$, $p < .0005$, with males reporting higher amounts of positive affect (M = 29.36, SD = 7.165) than did females (M = 26.86, SD = 7.823). This effect was seen only when the aggregate of Minnesota and Non-Minnesota males were compared with the equivalent for females.

Discussion

No support was found for the study‟s hypothesis. Individuals indigenous to Minnesota and those relocated to Minnesota failed to significantly differ in their expressions of positive affect in response to good weather days nor negative affect in response to bad weather days, thereby refuting the prediction that relocated persons would display greater overall mood variability. This would initially suggest that the individual need not give the weather conditions of a prospective location undue consideration before they geographically relocate, an event which has become a relatively regular occurrence in today‟s fluid society. Rather, if weather is to play a factor in the individual‟s decision concerning relocation, they may ask themselves merely if they will enjoy the weather rather than contemplating the more serious question of how the novel weather conditions may enhance or curb their moods. However, examination of results tangential to the tested hypothesis makes such weather-related relocation considerations slightly more complicated.

Despite a lack of evidence for the hypothesis, significant changes in affect were nevertheless found in response to weather as each a general category (bad weather days) and a specific variable (amount of sunshine). Addressing weather as a general category first, the aggregate of Minnesota and non-Minnesota participants experienced significantly higher levels of negative affect in response to bad weather days when juxtaposed with both good and indeterminate weather days. It may be recalled that the requirement for bad weather day classification entails a below 3 sunshine rating and the day‟s high temperature must fall below the mean high temperature for that particular calendar date. This increase in negative affect appears to validate the popularized public notion that declines in mood occur during bad weather, and this deterioration is directly linked to the weather itself rather than the circuitous illusory correlation explanation proffered by Watson (2000). It should be reiterated the important role which sunshine amounts play in good/bad weather day classifications considering the responsiveness in mood to sunshine when this variable is measured in isolation (which will be discussed further below).

Participants in the Minnesota condition experienced significantly higher levels of negative affect on good weather days than did non-Minnesota participants, a peripheral finding in regards to the examined hypothesis, yet nevertheless not wholly unrelated. While it was predicted that non-Minnesotans would experience heightened moods on good weather days as compared to Minnesotans, it was believed this elevated mood would come in the form of higher positive affect. However, no significant differences in positive affect were seen between these groups during good weather days.

Second, in regards to specific weather variables, sunshine amount produced a significant effect in the manifestation of negative affect. Regardless of geographic condition, participants

experienced greater negative affect on days with a sub-3 sunshine rating than on days with a sunshine rating of 3 and above. In spite of the inability to elicit changes in positive affect, this result clearly portrays sunshine as a powerful mood determinant, which confirms the findings of several other studies reporting sunshine and its contribution to mood manipulation (Howarth & Hoffman, 1984; Parrott & Sabini, 1990; Schwarz & Clore, 1983). A darker day, therefore, tends to elicit a darker mood.

Despite a significant effect for the participant aggregate, only the non-Minnesota geographic condition exhibited a significant response to sunshine amounts when the geographic conditions are examined separately. Whereas any explanation for this phenomenon is pure conjecture, it may be that indigenous residents are entrained to the locality‟s climate so as to make the presence or absence of sunshine unable to evoke any substantial alteration in mood.

As noted previously, positive affect was unaffected by any weather variable or classification. Does this mean that these emotions require substantially greater impetus acting upon them or that positive affect possesses a higher threshold which needs to be met in order to elicit significant changes? While it is beyond the scope of this study to make generalizations regarding the nature of positive affect‟s precise means and reason for regulation, it clearly appears that it is more resistant to fluctuations in response to the weather.

It appears that sunshine is the integral factor for the reduction of negative affect and, consequently, improvement in comprehensive mood. These effects can be best conceptualized as an addition-by-subtraction model of operation; that is, the individual experiences a boost in their overall mood through the diminution of negative affect. The reciprocal would also apply under such a model: global mood would decrease through diminished positive affect, although this effect was not seen in the current study. Such a model requires the assumption that

comprehensive mood can be elevated or diminished merely through the addition or subtraction of positive or negative affects, respectively. Why should this approach to measuring global mood be a problem? After all, positive and negative affect are separate and distinctive constructs, despite retaining modest levels of correlation with one another. However, using any single-affect approach for measurement should be cautioned against because, despite any given degree of independence, traits and affective states invariably remain correlated to some extent with additional affective or personality factors (Watson & Clark, 1997). Therefore, an addition-by-subtraction model may be too simplistic to illustrate mood‟s instrumental functioning. Nonetheless, such a model is an appropriate conceptualization for, at minimum, understanding how sunshine modified participant mood in the present study.

The aggregate of Minnesota and Non-Minnesota males indicating higher positive affect levels than the corresponding total for females was the sole significant effect involving gender. While it should be of no surprise that participants consistently scored higher on the positive affect scale than the negative affect scale, an outcome generally seen with the PANAS (Watson et al., 1988), it is unclear why males expressed comprehensively greater positive affect. Speculation from the data could lead one to suggest that males maintain a more positive disposition by nature, yet any such assertion should be withheld until a more plausible explanation can be tendered.

Limitations

A number of limitations in the present study should be examined so they can be addressed in any future inquiry of the weather-mood relationship. The first considers the attempt itself to isolate and measure the impact which weather by itself has upon our moods and apart from the plethora of confounding variables which influence our general cognitions and emotions,

literally on a minute-by-minute basis. It is, of course, impractical to segregate the study participant from their everyday environment in order to insulate them from all potential confounds which may bias their mood. Scoring extremely well or extremely poorly on an exam, having an extension to a date accepted or turned down, or even if the school‟s team won an athletic competition are all examples of sources which could have influenced the college students who comprised the study sample, which says nothing of more universal confounds which can be generalized to everyone such as amount of obtained sleep, illness, or experiencing vehicle difficulties. The point being, any investigation of mood‟s responsiveness to weather must be cognizant of a multitude of potential confounding variables.

This profusion of influencing factors may be one of several reasons why there has been relatively little examination of the mood-weather phenomenon. This, in fact, appears to be a more legitimate empirical reason why researchers are hesitant to undertake such studies than the immeasurability of descriptors as suggested in Persinger (1980). The notion that there lies an enhanced validity in measuring affective response to weather within the greater context of the individual‟s mundane activities should not be immediately discarded. Being as we experience weather as a component of our external environment, would not greater validity exist if affective response was likewise measured when merely a component of the experienced surroundings? Any deliberation regarding the merits of such an investigative approach can be successfully argued either way.

It may be recalled that the prerequisite for assignment to the non-Minnesota condition required the participant having spent a minimum of one year living somewhere other than in Minnesota. This requirement for non-Minnesotan categorization was not as stringent as would have been preferred; however, such a lenient qualification was justified through the necessity of

boosting that particular categories‟ sample size. It is entirely plausible that a participant in the non-Minnesota condition spent their initial 3 years on either of the coasts, but yet has spent the most recent 15 years residing in Minnesota with their emotional reactivity having become entrained to the local climate. Such an individual, despite being categorized in the non-Minnesota condition, would be more representative of someone indigenous to Minnesota. Participants assigned to the non-Minnesota condition would ideally have only recently relocated to the area after having spent their entire lives in distinctly diverse regions. Fortunately, however, a history of residence such as described was atypical amongst participants, and it is therefore regarded that the present geographic classifications are valid.

Despite the ample aggregate number of daily surveys utilized for data analysis (1918 surveys), it may be possible that an effect was nonetheless missed due to a substantial number of days during which the daily survey went uncompleted. Whereas data collection ran for 28 consecutive days, the vast majority of participants failed to complete the daily survey (and thus record their mood via the PANAS) for all days. The average amount of surveys completed by each participant numbered 20, or approximately 71% of the potential maximum. Recall that a minimum of 14 completed surveys, or 50%, was a prerequisite to include that participant‟s data in the analysis. It was felt that such a minimum criterion was necessary for two reasons. One, it would bring a continuity to each participant‟s exclusive data and be therefore possible to build a “mood profile” for each participant when viewed longitudinally, and, two, to ensure the probability of having a sufficient sample of daily surveys for each day. This goal was accomplished as the number of surveys collected daily ranged from 30 to 86, with a mean of 68.5. Nevertheless, with approximately 29% of potential daily surveys having remained

uncompleted, the possibility remains that an imprecise portrait was obtained of how participant moods respond to the weather.

A further limitation to the current study pertains to the randomized times which the daily survey was completed. In spite of the criterion that they wait until at least noon before completing the survey, this still left participants a 12 hour time period (noon to midnight), and this entire range was indeed utilized for survey submittal. This begs the question of how similar are experienced weather conditions on a given day for different subjects when, for example, one participant completes the survey at 1 p.m. whereas the next completes the survey at 10 p.m. Their measured affect would be subsequently coupled with weather information categorized as identical, a partially inaccurate interpretation due to occasions of notable alternative weather conditions manifesting themselves later in the day; such conditions would be experienced by the later survey submittal but not by the early submittal. An ideal model of data collection would have been for participants to complete the daily survey at identical times each day. However, such a scheduling arrangement would have been next to impossible to implement considering both the participant‟s varied personal schedules and that online surveys were utilized rather than laboratory appointments.

Future Research

Future research into the weather-mood relationship is open to a manifold of variations in approach. Future studies could involve utilizing longer measurement periods as insignificant effects in this study may require extended time frames to manifest themselves; examining affect response to a broader scope of weather and seasonal variables to determine any degree of interrelatedness; finally, examining mood as a univariate construct rather than the dichotomous positive affect-negative affect model featured by the PANAS. Using the PANAS to illustrate, a

positive value is assigned to the total score of the positive affect scale whereas the negative affect scale‟s total score is assigned a negative value. The addition of the two values, one positive and one negative will yield a single overall affect score which could then be easily placed on an affect scale continuum representing interval data. No psychometric properties for the scoring of the PANAS in such a manner exist, however, making the reliability and validity of just such an approach unsound. Furthermore, a thorough review of the literature regarding such univariate methodology (Watson & Clark, 1997) should be undertaken.

This study addresses the void in the literature regarding how identical weather conditions affect mood in individuals from differing geographic locations. Participants completed the PANAS (Watson et al., 1988) once daily for four consecutive weeks to record affect, and this data was then matched with weather data from the corresponding time period. No significant difference was found regarding the hypothesis that relocated individuals would experience heightened mood variability when juxtaposed with indigenous individuals. However, several significant findings were found in response to specific meteorological variables, with sunshine found to be an especially influential factor in mood fluctuation.

Bibliography

Allport, G. W. (1937). *Personality*. London: Constable.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

Batson, C. D. (1979). Generality of the "glow of goodwill": Effects of mood on helping and information acquisition. *Social Psychology Quarterly, 42,* 176-179.

Clark, L. A., & Watson, D. (1988). Mood and the mundane: Relations between daily life events and self-reported mood. *Journal of Personality and Social Psychology, 54,* 296-308.

Clark, M. S., & Isen, A. M. (1982). Toward understanding the relationship between feeling states and social behavior. In A. Hastorf & A. M. Isen (Eds.), *Cognitive social psychology* (pp. 73-108). New York: Elsevier.

Cunningham, M. R. (1979). Weather, mood, and helping behavior: Quasi-experiments with the sunshine samaritan. *Journal of Personality and Social Psychology, 37,* 1947-1956.

Ennis, E., & McConville, C. (2004). Stable characteristics of mood and seasonality. *Personality and Individual Differences, 36,* 1305-1315.

Epstein, S. (1984). The stability of behavior across time and situations. In R. A. Zucker, J. A. Aronoff, & A. I. Rabin (Eds.), *Personality and the prediction of behavior* (pp. 209-268). San Diego, CA: Academic Press.

Goldstein, K. M. (1972). Weather, mood, and internal-external control. *Perceptual Motor Skills, 35,* 786.

Guilford, J. P. (1959). *Personality*. New York: McGraw-Hill.

Howarth, E., & Hoffman, M. S. (1984). A multidimensional approach to the relationship between mood and weather. *British Journal of Psychology, 75,* 15-23.

Larsen, R. J. (2000). Toward a science of mood regulation. *Psychological Inquiry, 11,* 129-141.

McConville, C., & Cooper, C. (1997). The temporal stability of mood variability. *Personality and Individual Differences, 23,* 161-164.

McGrath, J. E., Kelly, J. R., & Machatka, D. E. (1984). The social psychology of time: entrainment of behavior in social and organizational settings. *Applied Social Psychology Annual, 5,* 21-44.

National Oceanic and Atmospheric Administration. (n.d.). Retrieved November 22, 2006, from http://www.noaa.com/

Morris, W. N., & Reilly, N. P. (1987). Toward the self-regulation of mood: Theory and research. *Motivation and Emotion, 11,* 215-249.

Parrott, W. G., & Sabini, J. (1990). Mood and memory under natural conditions: Evidence for mood incongruent recall. *Journal of Personality and Social Psychology, 59,* 321-336.

Penner, L. A., Shiffman, S., Paty, J. A., & Fritzsche, B. A. (1994). Individual differences in intraperson variability in mood. *Journal of Personality and Social Psychology, 66,* 712-721.

Persinger, M. A., (1980). *The weather matrix and human behavior*. New York: Praeger Press.

Reid, S., Towell, A. D., & Golding, J. F. (2000). Seasonality, social zeitgebers and mood Variability in entrainment of mood: Implications for seasonal affective disorder. *Journal of Affective Disorders, 59,* 47-54.

Rosenthal, N. E., Genhardt, M., Sack, D. A., Skwerer, R. G., & Wehr, T. A. (1987). Seasonal Affective Disorder: relevance for treatment and research of bulimia. In J. I. Hudson, & H. G. Hope (Eds.), *Psychobiology of bulimia*. Washington, DC: American Psychiatric Press.

Rosenthal, N. E., & Wehr, T. A. (1987). Seasonal affective disorders. *Psychiatric Annals, 17,*

670-674.

Sanders, J. L., & Brizzolara, M. S. (1982). Relationships between weather and mood. *Journal of General Psychology, 107,* 155-156.

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgment of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology, 45,* 513-523.

Sher, L. (2001). Genetic studies of seasonal affective disorder and seasonality. *Comprehensive Psychiatry, 42,* 105-110.

Sher, L., Goldman, D., Ozaki, N., & Rosenthal, N. E. (1999). The role of genetic factors in the etiology of seasonal affective disorder and seasonality. *Journal of Affective Disorders, 53,* 203-210.

Watson, D. (2000). *Mood and temperament*. New York: Guilford Press.

Watson, D., & Clark, L. A. (1997). Measurement and mismeasurement of mood: Recurrent and emergent issues. *Journal of Personality Assessment, 68,* 267-296.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of Positive and Negative Affect: The PANAS Scales. *Journal of Personality and Social Psychology, 54,* 1063-1070.

Author biography:

Jamie Scott graduated from Minnesota State University, Mankato in the spring of 2007 with a Bachelors of Science degree with Honors in Psychology after having begun his studies at Riverland Community College. Jamie Scott has also been accepted into the Clinical Psychology doctoral program at Northern Illinois University in DeKalb. His current research interests are primarily in the general area of anxiety disorders, and more specifically in finding the causes of

development and the means for the successful treatment of generalized anxiety disorder, obsessive-compulsive disorder, post-traumatic stress disorder, and social anxiety. Jamie Scott was a member of the inaugural Psychology Honors program at Minnesota State University, Mankato, and he has been regularly named to his school‟s President‟s List and Dean‟s List. He has been the recipient of multiple scholarships while attending Riverland Community College. Amongst his professional affiliations are the Association for Behavioral and Cognitive Therapies, Psi Chi National Honor Society, and Phi Theta Kappa International Honor Society. He has extensive research experience, highlighted by conducting an independent study examining the relationship between mood and weather, a study in which external funding was procured, with the results orally presented at the Undergraduate Research Conference in April, 2007 in Mankato.

Faculty mentor biography:

Dr. Jeffrey Buchanan is an Assistant Professor of Clinical Psychology at Minnesota State University in Mankato, Minnesota for approximately three years. Dr. Buchanan received his Ph.D. in Clinical Psychology (with an emphasis in geropsychology) from the University of Nevada. He also completed a clinical internship and post-doctoral fellowship at the Veteran‟s Affairs Hospital in Minneapolis, MN. Among the courses Dr. Buchanan teaches at MSU are Abnormal Psychology, Behavioral Assessment, Health Psychology, and Psychology of Aging. Dr. Buchanan has extensive research and clinical experience working with older adults with a variety of psychological conditions such as depression, anxiety disorders, relationship issues, grief/loss, and caregivers stress. Much of his research is conducted in long-term care facilities and is designed to improve quality of life of both direct care staff as well as residents with

cognitive impairments. His current research is in the areas of managing challenging behaviors such as agitation and aggression in dementia patients, training long-term care staff to use non-pharmacological behavior management strategies, developing methods to increase the frequency of positive emotional experiences in dementia patients living in long-term care, the assessment of ageism, the analysis of communication styles used by nursing assistants when caring for persons with dementia, and stress and coping among caregivers of persons with dementia.