ASSESSING THE HUMAN EXPERIENCE OF WEATHER AND CLIMATE: A FURTHER EXAMINATION OF WEATHER SALIENCE

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1. Introduction

In what ways are weather and climate (and changes in weather and climate) psychologically significant to people? How is the importance that people attach to weather and climate manifested on cognitive, emotional, and behavioral levels? These questions are addressed in the present project which describes the further development and evaluation of a psychological measurement tool, the Weather Salience Questionnaire (WxSQ, Stewart, 2005). The WxSQ is meant to assess the extent to which people find the weather and climate to be salient to various aspects of their lives.

The salience of weather and climate information should be studied because anecdotal observations suggested that people differ in the extent to which weather and climate affects their decision-making, their emotional experiences, and their behaviors. In this regard, the construct of weather salience may be an important variable to consider insofar as it may affect the extent to which people seek and use weather-related information during hazardous or severe weather events. Conversely, extreme weather events such as hurricanes Katrina and Wilma in 2005 may result in increased weather salience given the property destruction, injuries, and deaths that they caused. Thus, weather salience may both affect preparatory responses prior to dangerous weather and by affected by such weather.

The sections that follow describe: 1. the development of the WxSQ items, the sample of individuals who responded to them, and the research methodology, 2. the WxSQ's factorial validity, 3. the summary statistics for the WxSQ subscales and gender differences in WxSQ scores, 4. the relationship of WxSQ total and subscale scores with the experiencing of severe weather events and the use of consumer weather instruments, and 5. the WxSQ's relationship with other measures of environmental salience and with a measure of seasonal effects upon mood.

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2. Development of the Weather Salience Questionnaire (WxSQ)

The author, who is a researcher in counseling psychology and also a student in an atmospheric science training program, developed an initial pool of 53 WxSQ items. The content of the items stemmed from information gathered in interactions with clients and students regarding their general orientation to and experiences of weather and climate. The author created the items to reflect the many different ways that people may find aspects of weather and climate significant in their lives. As the author created the items it became apparent that the item content addressed at least seven areas in which weather and climate may be salient to people. These content areas included: 1. peoples' weather/climate information-seeking behaviors, 2. the extent to which weather and climate affects their moods, 3. their behaviors of sensing and observing the atmosphere directly, 4. their attachment to particular weather conditions, 5. their needs to experience changes and variety in weather conditions, 6. the effects of weather on their activities of daily life, and 7 interest in weather during the possibility of a weather-related holiday. Multiple items were created to assess each of these six content areas. The author then created a five-point rating scale for use in responding to the items. For some items the scale indicated the frequency of a weather-related behavior (*1 = Never to 5 = Always*); for other items the scale was used to indicate the degree of agreement (*1 = Strongly disagree to 5 = Strongly agree*) with the item.

3. Participants & Methodology

The participants for this research project were 946 undergraduate students from the University of Georgia who voluntarily responded to the WxSQ in exchange for course credit. This sample included 283 men and 663 women whose ages ranged from 17 to 46 years (*M* = 19.2 years, *SD* =1.8). The participants were primarily Caucasian American (86%), followed by African American (4%), Asian American (4%), Hispanic American (1%) and 5% other. The WxSQ was administered online via the Internet along with several additional instruments that were part of a larger research project to explore how people experience weather and climate. The research participants also responded to questions regarding

their demography, ownership and use of consumer weather instruments, and about various severe or threatening weather events that resulted in either damage to their or their family's property or to injuries they or their family members sustained (e. g., floods, hurricanes, winter storms, thunderstorms, and tornadoes).

The data for this project were collected in three waves: 1. April 1 – 24, 2004 (*N* = 278 participants), 2. September 13 – October 19, 2004 (*N* = 521), and 3. October 4 – October 25, 2005 (*N* = 147). This protracted data collection allowed the author to have people respond to the WxSQ and other research instruments of the project during varied weather and climate regimes. In this regard the Fall 2004 data collection was noteworthy in that it occurred during the interval of time when the tropical storm remnants of hurricanes Frances, Ivan, and Jeanne significantly affected the Athens, Georgia area via torrential rains, tropical storm-force winds, and heavy thunderstorms, several of which produced small and short-lived tornadoes.

Concerning statistical procedures in this project, the author used the Analysis of Moment Structures (AMOS, Arbuckle & Wothke, 1999) to perform an exploratory factor analysis of the WxSQ measurement model and to refine this model. The author used the Statistical Analysis System (SAS) to calculate descriptive statistics, correlation coefficients, and to check for differences on WxSQ total and subscales according to participant gender, ownership of thermometers and other weather instruments, and whether or not they experienced harmful effects (property damage) from floods, hurricanes, winter storms, thunderstorms, or tornadoes.

4. Factorial Validity of the WxSQ

The author conducted an exploratory factor analysis of the 53 original items to assess the extent to which they measured the seven aforementioned constructs that exemplified weather salience. Although it was expected that the items created to assess a given construct would load most highly on the corresponding factor, it was not expected that all items would be retained in the final version of the WxSQ or that items would load onto factors in unanticipated ways. In this regard the author used the AMOS program to explore the factor structure of the WxSQ and to refine the measurement model so that it would exhibit an optimal fit to the data.

Twenty-nine items were retained for the seven WxSQ subscales following the factor analysis. The nature of these scales and the number of items of measuring each one appear in Table 1. Two of these items demonstrated significant loadings on two factors while the remaining 27 items loaded onto a single factor only.

Table 1: Content Assessed by the WxSQ

1. Seeking weather/climate information from multiple media and electronic sources (9 items)
2. Effects of weather (and changes in the weather) on mood state (6 items)
3. Sensing and observing atmospheric conditions directly (i. e., in person) (5 items)
4. Psychological attachment to particular weather/climate conditions (3 items)
5. Need to observe or experience changes/variety in weather and climate (4 items)
6. Increased interest in the weather and enjoyment during weather-related holiday periods (3 items)
7. Effects of weather (and weather changes) on activities of daily life (e. g., work, school, and daily tasks) (3 items)

The relatively large sample size likely contributed to the statistically significant chi-square statistic assessing overall model fit, χ^2 (*N* = 946, df = 348) = 657.68. Otherwise, the final WxSQ measurement model demonstrated an excellent fit to the data: Root Mean Residual = .03, Goodness-of-Fit Index = .95, Adjusted Goodness-of-Fit = .94, Normed Fit Index = .92, Incremental Fit Index = .96, Tucker-Lewis Index = .96, Cumulative Fit Index = .96, Root Mean Square Error of Approximation = .03.

Cronbach's coefficient α was calculated for each WxSQ subscale and for the total scale to assess the extent to which they were internally consistent. These coefficients appear in Table 2. Most of the subscales demonstrated good internal consistency reliability, indicating that the constituent items were contributing to the measurement of a central theme within each subscale. In the cases where the internal consistencies were less than .80, the brevity of the subscales (between 3 to 5 items each) probably contributed to the decreased reliability. The α of .83 for the 29 items that make up the WxSQ total scale suggested that all of the items functioned together to assess the general construct of weather salience.

5. Descriptive Statistics for the WxSQ

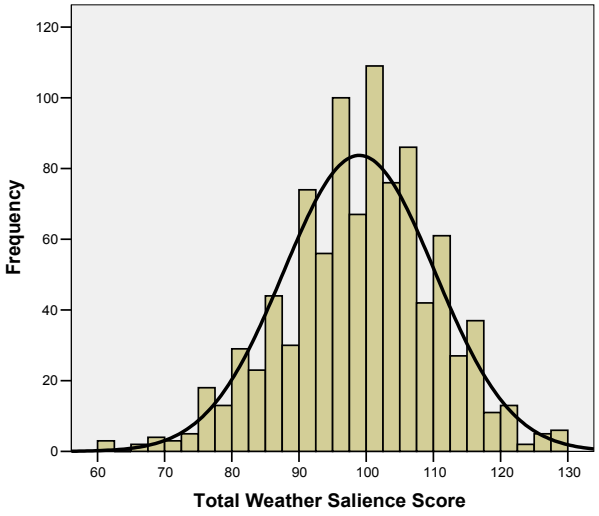
The 7 subscales can be summed to provide an overall indication of the extent to which the weather and climate are salient to people. Figure 1 depicts the distribution of total scores on the WxSQ. Overall, the scores were almost perfectly normally distributed (*M* =

99.0, *SD* = 11.3) with a median of 100 and a mode of 103. The minimum score in the sample was 60 and the maximum was 130 out of a scale maximum of 145. Statistical tests suggested that the WxSQ total score did not deviate significantly from a standard normal distribution. These results suggested that overall weather salience is a normally-distributed characteristic among the respondents included in the sample.

Table 2: Coefficient α Values for the WxSQ

Subscale	Coefficient α
Seeking Weather Information	.82
Effects of Weather on Mood	.84
Sensing and Observing Weather	.64
Attachment to Kinds of Weather	.84
Need for Variety in Weather	.64
Holiday-Related Weather Interest	.72
Effects of Weather on Daily Life	.46
All Items (Total Salience)	.83

Figure 1- Distribution of Total Weather Salience Scores



WxSQ scores differed significantly according to respondent gender. Women (*M* = 29.7, *SD* = 5.4) reported significantly greater salience with respect to needs and usage of weather information than men (*M* = 28.0, *SD* = 6.4), *t* (459) = 4.00, *p* < .0001. Similarly, women (*M* = 21.8, *SD* = 3.7) reported that weather and climate was more salient to them in that it had a greater effect on their moods compared to men (*M* = 19.6, *SD* = 4.4), *t* (458) = 7.63, *p* < .0001. These subscale differences along with other non-significant trends in subscales contributed to gender differences on the total WxSQ scale. Here, women (*M* = 100.0, *SD* = 10.3) reported significantly higher overall weather salience than men did (*M* = 96.6, *SD* = 12.9), *t* (444) = 3.86, *p* < .0001. Given these results, gender was included as an effect in subsequent analyses of variance that examined differences in weather salience according to the respondents' experiences of severe weather and according to their use of thermometers, among other variables.

6. WxSQ Differences According to the Experience of Severe Weather Events

If the WxSQ is measuring dimensions of weather and climate experience that are of practical importance to people, then it was thought that the instrument would reveal differences between people who had (versus had not) experienced a variety of severe weather events that resulted in damage to their property (or that of their family). Observing such relationships would both support the validity of the WxSQ and also reveal ways that the instrument could be used in the aftermath of such weather to evaluate its effects upon people.

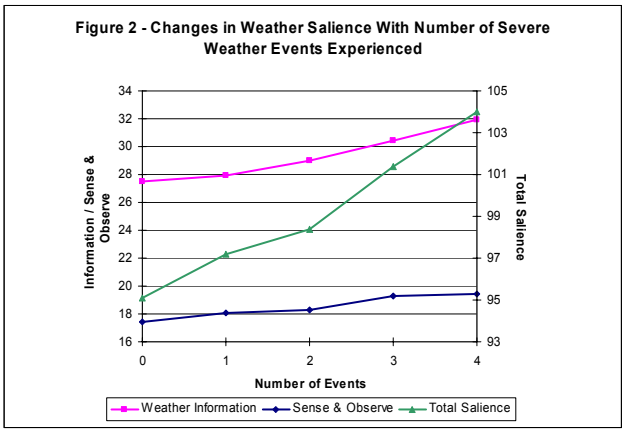
The participants were asked in a demographic section preceding the WxSQ to indicate whether or not they or their families had experienced property damage from floods, hurricanes, winter storms, thunderstorms, and tornadoes. People also were asked to indicate whether or not they had to evacuate their homes because of an approaching hurricane. Although respondents were asked to indicate whether they had received injuries from the severe weather events listed above, an insufficient number of such injuries were reported to permit analyses of their relationship with weather salience.

In beginning these analyses the author was interested in the cumulative effects upon weather salience of experiencing property losses from multiple severe weather events. It was observed that some people in the sample (*N* = 230) reported that they had never experienced property damage from a severe weather event. There were 228 who reported property damage or loss from one event, 283 from two events, 134 from thee events and 62 from four such events. The most frequently experienced events (i. e., from one to four events) consisted of damage or losses from thunderstorms and from winter storms. Given the geography of the research site (i. e., Athens, Georgia) it is not surprising that these events were cited as the most frequently-occurring causes for property damage or loss. The proportions of losses attributed to hurricanes and tornadoes increased as people reported experiencing three and four events.

Damage from floods was less frequently cited; this result made sense given the mean age of the respondents along with the fact that the southeastern United States experienced drier than normal conditions do the 1998-2002 La Niña episode.

The author performed analyses of variance to examine the extent to which WxSQ scores might reflect differences stemming from the experience of property damage and loss from multiple severe weather events. Differences were observed in three WxSQ scales, beginning with weather information salience, $F(4, 931) = 10.09$, $p < .0001$. People experiencing damage or losses from two events reported a significantly greater level of information salience than those who experienced no damage ($p = .0089$). People experiencing damages from three or four events reported significantly greater information salience compared to people who experienced damages or losses from one or two events. Figure 2 depicts the changes in the mean value of information salience. A similar pattern of results emerged for sensing and observing the weather, $F(4, 931) = 10.76$, $p < .0001$. People who experienced damages from one or more events reported increased sensing and observing of the weather compared to those who experienced no damages (all $p < .018$). Sensing and observing did not significantly increase between people who experienced one or two events. People experiencing damage from three or four events evidenced greater sensing and observing than those experiencing no, one, or two events (all $p < .0061$, see Figure 2). Total weather salience exhibited a similar pattern of increase with the number of severe weather events experienced, $F(4, 931) = 10.25$, $p < .0001$. People who experienced damages from two or more events reported significantly higher total weather salience compared to people who experienced no or only one event (all $p < .0028$). People who experienced damages from three or more events evidenced significantly greater total salience than those who experienced two or fewer weather events that produced damages or losses (all $p < .012$, see Figure 2).

These analyses indicated that significant increases in weather salience did not occur unless individuals experienced repeated damages or losses of property from multiple severe weather events. These results should be interpreted with caution because of the coarse nature of the inquiry about weather-related property damages. The respondents were not queried about the *amount* of damage or about the *severity* of the event that occasioned the damage or loss. Further research efforts will attempt to assess these variables more precisely.



An additional item on the demographic form inquired about whether the respondents had experienced a motor vehicle crash that was due in whole or part due to the weather conditions. It was expected that such an experience may subsequently affect the crash survivors' weather salience in various ways. As reported in Table 3, people who sustained a weather-related crash reported that the weather was salient with respect to its affect on their moods and on how they performed daily life tasks. People who experienced a weather-related crash reported significantly greater salience that those who did not.

Finally, it was suspected that the practical relevance of weather salience would be demonstrated to the extent that people who indicated a high degree of salience on the WxSQ would possess and use thermometers (one of the most readily available and used of instruments). Such a result would imply that weather salience comprises not only an attitude or value, but also has a concrete, real-life exemplar in the use of a thermometer. Table 3 shows that for nearly all the WxSQ subscales and for the total scale, the ownership and use of a thermometer is associated with significantly greater weather salience. The only subscale that did not exhibit a difference across the two groups was the weather holiday subscale.

Taken together, these results suggest that severe weather events that result in property damage tends to make various psychological aspects of weather, as measured by the WxSQ, more salient. People who have experienced weather-related vehicular crashes find the weather more psychologically salient to them as do people who own and use thermometers. That the WxSQ was able to detect such differences between people supports the concurrent validity of the instrument.

7. Relationships with Other Measures

The author investigated the convergent validity of the WxSQ by assessing its degree of relationship with other established measures of environmental orientation and with a measure that was developed to screen for seasonal depressive disorders. Although the WxSQ differs from these existing measures, it was expected that it would exhibit some degree of relationship with these instruments in that they all pertain in various ways to the relationship a person has with his or her natural environment. The observation of statistically significant relationships of the WxSQ with other measures would contribute to the convergent validity of the WxSQ.

During the Fall 2004 data collection the participants completed two measures assessing attitudes and orientations toward the environment, the Environmental Identity Scale (EIS, Clayton & Opotow, 2003) and the Environmental Attitude Scale (EAS, Thompson & Barton, 1994). Each measure has found uses in the field of environmental psychology. The EIS comprises a single scale; higher scores suggest that the physical and natural environment contributes in an increasing way to one's sense of personal identity. The EAS comprises three subscales, one of which measures an ecocentric orientation that involves being cognizant of and respectful towards the environment. An anthropocentric scale assesses attitudes that the environment is a resource that is meant to be used for human's purposes and that it is not necessarily valuable in its own right. The apathy scale of the EAS assesses attitudes of not caring or being concerned with the nature or state of the environment. The Seasonal Pattern Assessment Questionnaire (SPAQ, Rosenthal, et al., 1987) assesses changes in a variety of variables such as sleep patterns, appetite, energy level, and mood as a result in the change of seasons. The SPAQ is meant to be a screening instrument for Seasonal Affective Disorder. People responded to the SPAQ during both the Fall 2004 and Fall 2005 data collection intervals.

Table 4 presents the correlations of the WxSQ with the EIS, EAS, and SPAQ. The correlations were all in the expected directions. Greater levels of environmental identity were associated with greater levels of sensing and observing the weather, with desiring weather variety, and with overall weather salience. This result suggests weather salience, and it facets, represent one way that people orient themselves to the natural environment. That is, finding weather and climate salient may contribute to one's environmentally or ecologically-based sense of identity. Similarly, higher levels of ecocentric attitudes on the EAS were associated with greater levels of sensing and observing the weather, with needing weather variety, and with overall salience. A slight degree of relationship was between anthropocentric attitudes and attachment to weather and overall salience. No significant correlations were observed between weather salience and the EAS-environmental apathy scale.

Similarly supportive convergent results were observed with the SPAQ. Greater levels of seasonal changes in energy, appetite, mood and so forth were significantly related to people finding the weather and climate to be salient with respect to its effect on their moods. It was also not unexpected that the effects of weather on daily life activities were positively related to SPAQ scores. In other words, people who indicated the weather affected their lives on a daily basis also indicated it affected them on a seasonal timeframe as well. Finally, the total salience score was positively correlated with the SPAQ. As seasonal influences on people increase, this is associated with a greater overall degree of weather salience (and vice versa).

8. Discussion and Conclusions

The present project built upon the author's prior work (Stewart, 2005) in weather salience to further refine the items on the questionnaire and to examine the WxSQ's construct, concurrent, and convergent validities. The results of these analyses were supportive of the WxSQ as a measure that reflects the extent to which people find weather and climate to be salient on cognitive (i. e., weather information), emotional (weather-mood effects), and behavioral (sensing and observing) levels.

Several conclusions follow from the results of this research. First, it appears that the construct of weather salience is a multi-faceted one that can be measured by a set of written items to which people respond via the Internet. These facets together all seem to assess the broad construct of weather salience. The ways in which the items relate to one another to assess the WxSQ subscales demonstrates a good fit to the data. Second, like many human characteristics and abilities, it appears that the degree of weather salience is normally distributed among people. This means that some people will find the weather and climate of their surroundings something that is highly engaging such that they are attuned to it on multiple levels. On the opposite end, other people seem not to be affected more than minimally by the weather and climate of their surroundings. Most other people are somewhere in the middle of these extremes. In this regard, the familiar quote attributed

to Benjamin Franklin seems appropriate, "Some people are weather wise, but most are otherwise."

A third and interesting conclusion concerns the gender differences observed in WxSQ scores. Previous psychological research has documented the greater seasonal fluctuation in women's moods (e. g., Spoont, Depue, & Krauss, 1991) and prevalence rates of seasonal affective disorder compared to men (American Psychiatric Association, 1994). Thus, at least some of the gender differences in weather salience may stem from the differential influences of weather on each gender's mood state. Beyond this, one may conjecture that because men may have historically spent more time exposed to various weather conditions through their work pursuits that current generations of men have been socialized to be less affected by weather and thus find it less salient. There is no data, however, to support this conjecture.

A fourth conclusion stemming from this project is that experiencing an increasing number of severe weather events that result in property damage or destruction appears to have an additive effect upon weather salience, especially those aspects that involve obtaining information from the media or Internet as well as being more attuned and observant of one's immediate weather conditions. Although the weather salience effects are not noteworthy when comparing people who have not experienced such an event with those who have experienced damage or losses from one event, the salience increase beyond one event is a noticeable one. These results have significant implications in that it only takes one sufficiently severe weather event to cause property damage, loss, injury, death as witnessed by the destruction stemming from hurricane Katrina. Weather salience for most people, however, does not increase appreciably until multiple events occur. The increased attention and preparation in advance of hurricane Wilma by local, state, and federal agencies seems to support this contention. This raises an important question and that is how to increase weather salience, at least in the informational, sensing and observing realms, *before* having to experience a severe or extreme event.

Fifth, the WxSQ demonstrated a mild, but significant degree of relationship with established measures of environmental orientations and attitudes. The implications of these findings are twofold in that a general heightened interested in or sensitivity to one's overall natural and physical environment may underlie, in part, weather salience. Conversely, the adaptive and evolutionary significance of being sensitive to and observant of the weather could form a major part of peoples' interest in the natural environment.

Overall, the concept of weather salience is significant because it bears upon the consumer-side of the use of weather and climate information. High quality weather and climate data exist, however people may fail either to seek such information or to implement behavior in response to the information depending upon the level of salience that they possess or the amount of weather-related losses/damages they have sustained previously. The construct of weather salience may help explain why some people do not seek or use weather information when they should or when they could otherwise benefit from it. Again, hurricane Katrina provided a tragic example of either not attending to accurate weather information or failing to act upon it despite its being received.

Weather and climate salience as a focus of inquiry draws upon meteorology, climatology, psychology and sociology with respect to the variables studied and the possible relationships between the variables. Weather salience is significant because it represents one of many possible lines of programmatic research within a new field the author refers to as Behavioral Climatology. Here, climatology remains the principal field because of its naturally integrative and multidisciplinary focus (Glanz, 2003). *Behavioral* denotes the sub-fields of inquiry as these relate to the broad and reciprocal relationships between climate on one hand and peoples' cognitive, behavioral, attitudinal, and emotional processes on the other.

The present study is limited in that it used undergraduate students from a university in the southeastern United States to study weather salience. A more diverse sample of respondents to the WxSQ with respect to age, socioeconomic status, geographical and climatic region of residence, is needed. Further efforts are being made to include a more heterogeneous sample of respondents so that this instrument may be revised or supplemented according to the diverse ways in which people may orient themselves toward the weather and climate. Collaboration in collecting this data and in conducting research with the WxSQ in furthering the study of Behavioral Climatology would be very much welcomed.

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Table 3: Weather Salience Questionnaire Differences According to Respondent Status on Selected Weather-Related Variables

Event	Weather Salience Scale	Mean Score (Yes / No)	F-Ratio	Significance Level
Evacuated because of hurricanes (*N* = 186 of 946)	Mood Effects	21.5 / 20.4	8.72	.0032
	Daily Life Effects	7.9 / 7.5	5.18	.0231
	Total Salience	100.4 / 97.8	6.64	.01
Experienced a weather-related motor vehicle crash (*N* = 311)	Mood Effects	21.3 / 20.4	9.27	.0024
	Daily Life Effects	7.9 / 7.4	7.65	.0058
	Total Salience	99.5 / 97.7	4.34	.0374
Ownership and use of a thermometer (*N* = 132)	Weather Information	31.1 / 28.5	23.17	<.0001
	Mood Effects	21.5 / 20.6	5.63	.0178
	Attachment to Weather	10.5 / 9.9	6.16	.0132
	Sense & Observe	19.3 / 18.2	17.8	<.0001
	Need for Weather Variety	13.8 / 12.9	13.59	.0002
	Daily Life Effects	8.1 / 7.5	8.95	.0028
	Total Salience	103.2 / 97.4	28.19	<.0001

Note: The df for all analyses were 1, 942. F-Ratios are for the main effects in the first column of this table after controlling for gender effects. The means reported are least square means adjusted for all of effects in the model. The significance levels reported are based upon two-tailed tests.

Table 4: Correlations of the Weather Salience Questionnaire with Measures of Environmental Orientation and with Seasonal Psychological Changes

WxSQ Subscale	EIS	EAS-eco	EAS-anthro	SPAQ
Seeking Weather Information	.13*	.06	.08	.07
Effects of Weather on Mood	.12*	.15*	.09*	.48**
Sensing and Observing Weather	.09	.07	.13*	.11*
Attachment to Kinds of Weather	.34**	.28**	.09	.07
Need for Variety in Weather	.21**	.22**	.06	.04
Holiday-Related Weather Interest	.02	.10*	.11*	.01
Effects of Weather on Daily Life	.12*	.04	.05	.30**
All Items (Total Salience)	.25**	.21**	.15*	.30**

Note: ** $p < .0001$, *$p < .05$. EIS =Environmental Identity Scale, EAS-eco = Environmental Attitude Scale – Ecocentricism, anthro = anthropocentrism, SPAQ = Seasonal Pattern Assessment Questionnaire. $N = 521$ for EIS and EAS correlations. $N = 668$ for SPAQ correlations.