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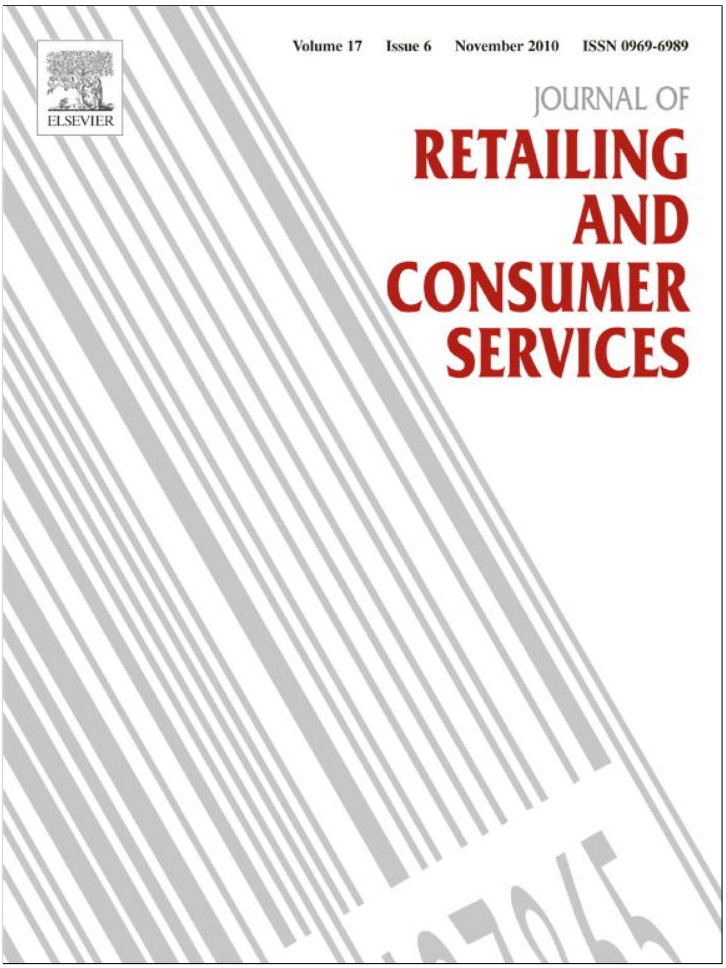

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# The effect of weather on consumer spending

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ABSTRACT

There has been a great deal of anecdotal evidence to suggest that weather affects consumer decision making. In this paper, we provide empirical evidence to explain how the weather affects consumer spending and we detail the psychological mechanism that underlies this phenomenon. Specifically, we propose that the effect of weather – and, in particular, sunlight – on consumer spending is mediated by negative affect. That is, as exposure to sunlight increases, negative affect decreases and consumer spending tends to increase. We find strong support for this prediction across a series of three mixed methods studies in both the lab and the field.



## 1. Introduction

Weather seems to influence human behavior in a variety of ways. Sometimes, weather influences general behavior. This occurred when Hurricane Katrina forced the temporary abandonment of New Orleans in 2005. Other times, weather influences specific consumption behaviors. For instance, the type of clothing we wear depends on the weather—e.g., we wear warmer clothing in the winter and cooler clothing in the summer.

Building on this type of anecdotal evidence, research has found that weather variables can affect human behavior. For instance, research in finance suggests that the weather may affect stock returns (Saunders, 1993; Trombley, 1997; Hirshleifer and Shumway, 2003; Goetzmann and Zhu, 2005) and that this effect may be attributed to the influence that weather has on mood (Cao and Wei, 2005; Kamstra et al., 2003). Similarly, research exploring the link between weather and a social activity has reported that higher temperatures are correlated with increases in violent assaults and homicides (Cohn, 1990a, 1990b). Researchers have also found that the number of suicides rise with increases in barometric pressure and with decreases in wind (Barker et al., 1994; Stoupel et al., 1999). In addition, results from several laboratory studies show that artificial sunlight reduces seasonal affective disorder (SAD) symptoms for the majority of SAD and non-SAD depressed participants (Kripke, 1998; Stain-Malmgrem et al., 1998).

Although the influence of weather on behavior has been explored in fields such as finance and psychology, it has been largely ignored in the marketing literature. However, there is anecdotal evidence that firms incorporate weather variables into models that they use to predict sales. For example, Wal-Mart lowered its June 2006 sales forecasts because unusually cool summer weather adversely affected sales of air conditioners, as well as swimming pool supplies. Coca-Cola developed vending machines that dynamically alter the price consumers are charged for the soft drink based on changes in the ambient temperature—i.e., the vending machines increase the price of a soda as the weather gets hotter (King and Narayandas, 2000).

Nevertheless, the effect of weather on consumer spending has received only limited attention in the marketing literature (Parker and Tavassoli, 2000; Parsons, 2001; Steele, 1951). Our work differs from prior studies as we employ a mixture of methods and types of data to investigate this issue. This approach is consistent with Winer (1999), which argues that it is necessary for theory application research in consumer behavior to establish both internal and external validity. It is important to not only establish how variables influence consumer behavior in an artificial laboratory setting, but also to determine whether these variables influence behavior in an actual retail setting. In addition, the research reported in this paper is the first to go beyond demonstrating an effect of weather on consumer behavior to propose and test the psychological mechanism (i.e., negative affect) through which a specific weather variable (i.e., sunlight) affects consumer spending. Importantly, we find that only negative affect mediates the effect of weather on spending (i.e., changes in positive affect do not impact spending).

Our work begins with an analysis of daily sales data, which establishes an effect of weather on consumer spending at one independent retail store. Building on the results of the first study,

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we investigate the effect of weather, and in particular, sunlight, on participants' moods and consumption using panel data. The third study uses a laboratory experiment to directly test the causal chain predicted by our theoretical model. We find strong support for the theory that the effect of weather – and, in particular, sunlight – on consumer spending is mediated by negative affect. In the next section, we review the literature in three relevant areas: the influence of weather on consumer spending, the influence of weather on mood and the influence of mood on consumer spending. We then describe the three studies we conducted, along with their results. We conclude with a general discussion of our findings.

## 2. Theoretical background

The extant literature has identified three general categories of effects that weather can have on consumer behavior. The first is relatively straightforward: bad weather keeps people at home. In particular, rain, snow and extreme temperatures have been identified as factors that can make going out to shop less attractive and, thereby, negatively affect both sales and store traffic (Parsons, 2001; Steele, 1951).

A second set of effects influence both sales volume and store traffic in particular product categories (Agnew and Thornes, 1995; Fox, 1993). For example, when temperatures fall, ice cream sales decrease, while sales of oatmeal porridge increase (Harrison, 1992). Similarly, people tend to purchase more clothing and footwear in the winter and more food and drinks in the summer (Agnew and Palutikof, 1999; Roslow et al., 2000). Retailers themselves are aware of such effects and use weather as a cue to begin and end merchandising seasons (Cawthorne, 1998). For example, gardening supplies begin to appear on store shelves with the arrival of spring weather, while the sale of snow shovels coincides with the onset of winter. In general, these studies point out that some products are better suited to, or even designed for, particular types of weather.

More interestingly, it has been suggested that weather can influence sales by affecting consumers' internal states. Although there is very little research that directly addresses this third category of effects, a few studies have provided preliminary support for this idea. For example, Parker and Tavassoli (2000) present a global climate-based model of the effect of weather on consumer behavior, which predicts variation in consumption patterns in response to different temperatures and exposure to sunlight. They argue that consumers do adapt to changes in the environment by modifying their purchasing behavior to both maintain physiological homeostasis and to achieve optimal stimulation levels. Of particular relevance to the current research is the authors' suggestion that consumers adapt to lower levels of sunlight, by consuming stimulants such as alcohol, coffee and cigarettes. Based on these previous findings, we predict that:

**H1.** Weather variables and, sunlight in particular, affect consumer spending.

Moreover, we go beyond this basic prediction, and extend the nascent stream of research that has examined the impact of weather on consumer behavior, by proposing and testing the following theoretical model: the effect of weather – and, in particular, sunlight – on consumer spending is mediated by mood. In the sections that follow we build on the work cited above, which indicates that the weather can affect sales, and we briefly review research that has established links between weather and mood, as well as between mood and consumer spending. We conclude our literature review with a section on the mediating role that mood has been shown to play in the effect of weather on behavior and extend those studies to predict that mood also mediates the effect of weather on consumer spending.

### 2.1. Influence of weather on mood

Overall, substantial research in psychology has confirmed that weather can influence an individual's mood. For instance, Persinger and Levesque (1983) examined the effects of temperature, relative humidity, wind speed, sunshine hours, barometric pressure, geomagnetic activity and precipitation on a unidimensional mood rating scale. They found that 40% of mood evaluations were accounted for by a combination of meteorological events; in particular, barometric pressure and sunshine had the strongest impact on mood. Other researchers employing varying mood scales have found that low levels of humidity (Sanders and Brizzolara, 1982), high levels of sunlight (Cunningham, 1979; Parrott and Sabini, 1990; Schwarz and Clore, 1983), high barometric pressure (Goldstein, 1972) and high temperature (Cunningham, 1979; Howarth and Hoffman, 1984) are associated with positive mood. Research has also found that weather's psychological influences are moderated by the season and the amount of time spent outside (Keller et al., 2005).

In addition to studies reporting an effect of weather on positive affect, research has shown that weather can also impact negative affect. In particular, exposure to sunlight improves peoples' mood by reducing negative affect. This effect appears to be associated with the production of serotonin in the human brain. Specifically, the rate of serotonin production is directly related to the length of exposure to sunlight, and rises rapidly with increased exposure to sunlight (Lambert et al., 2002). Artificial sunlight is also able to improve mood by reducing negative affect. Controlled laboratory studies have shown that artificial sunlight – produced, for example, by "sun lamps" – can improve mood and diminish SAD symptoms for both SAD and non-SAD depressed patients (Kripke, 1998; Stain-Malmgrem et al., 1998). Other studies utilizing artificial sunlight indicate that such lighting improves mood and vitality among non-depressed individuals (Leppamaki et al., 2002, 2003). This leads us to predict that with regards to mood sunlight is a particularly important weather variable and that it has its primary effect on the negative dimension of affect. Therefore,

**H2.** Exposure to sunlight reduces negative affect.

### 2.2. Influence of mood on consumer spending

According to Gardner (1985), mood is as a phenomenological property of an individual's perceived affective state. In addition, she argues that moods are mild, transient, general and pervasive states that may be particularly influential in retail or service encounters, because of their interpersonal or dyadic nature.

Empirical research suggests that people in positive moods are more likely to evaluate consumer goods (e.g., cars, TVs, etc.) more favorably than those in neutral moods (e.g., Bitner, 1992; Isen et al., 1978; Obermiller and Bitner, 1984). Prior work has also demonstrated that people in a positive mood are more likely to self-reward and tend to spend more money (Golden and Zimmerman, 1986; Sherman and Smith, 1987; Underwood et al., 1973).

In a store intercept study, Donovan et al. (1994) examined the relationship between shoppers' emotional states and their actual in-store spending. They found that more positive states resulted in greater overall spending. In related research, Spies et al. (1997) proposed that store atmospheric variables affect consumers' moods, which in turn affects their purchasing behavior. The authors compared the effects of two IKEA stores that differed in terms of their atmosphere (i.e., layout, interior colors, recency of

renovations, presentation of furniture, etc.). One of the stores, described as "pleasant," was rated as more attractive and appealing on these dimensions than the other ("unpleasant") store. They measured the effects of these differences on consumers' mood and spending. Their results indicate that consumers' moods improved during their time in the store with the more pleasant atmosphere. In addition, they found that customers' moods had a direct effect on how much money they tended to spend—that is, people in more positive moods spend more money.

These prior findings suggest that consumers in a better mood will tend to spend more money. We recognize that a consumer's mood can be improved by increasing positive affect or by decreasing negative affect, but prior research has not differentiated between these two distinct mechanisms. Given that we expect sunlight to reduce negative affect, we more specifically predict that:

**H3.** As negative affect decreases, consumer spending increases.

### 2.3. The mediating effect of mood

Previous research has demonstrated that weather influences behavior and that mood can *mediate* such effects (e.g., Barker et al., 1994; Cao and Wei, 2005; Cohn, 1990a, 1990b; Cunningham, 1979; Kamastra et al., 2003). The literature reviewed above provides support for the effect of weather on mood, the effects of mood on consumer spending, and the effect of weather on consumer spending. In addition, of the weather variables that have been studied, sunlight appears to play a particularly important role in improving mood (Keller et al., 2005; Kripke, 1998; Lambert et al., 2002; Leppamaki et al., 2003; Stain-Malmgrem et al., 1998). Specifically, both natural and artificial sunlight are able to improve mood by reducing negative affect. Similarly, the little research examining the relationship between weather and consumer spending suggests that sunlight is also an important factor in consumption decisions (e.g., Parker and Tavassoli, 2000). Therefore, as illustrated in Fig. 1, we predict that negative (but not positive) affect plays an important mediating role in the relationship between sunlight and consumer behavior. Specifically,

**H4.** Negative affect mediates the effect of sunlight on consumer spending.

We next present the results of three studies that examine the relationship between weather and consumer spending. Each study employs a different method in an attempt to triangulate the effect of weather on consumer spending with daily sales data, panel data and a laboratory experiment. The first study establishes the effect that weather can have on consumer spending by examining the correlation between a wide variety of weather variables and the daily sales of a small independent retailer. The results show that snow fall, humidity and sunlight all have significant effects on consumer spending. The second study focuses on correlations between weather variables and panel data, recorded by individual consumers in a daily diary, which captures consumption patterns and measures fluctuations in mood (positive affect and negative affect) over twenty days. We find that sunlight influences mood (negative affect), which subsequently affects consumption. The third study manipulates (artificial) sunlight in a laboratory setting. The results of this study confirm that negative affect can mediate the effect of sunlight on consumer spending decisions. Specifically, we find that participants exposed to artificial sunlight are willing to pay significantly more for a variety of products than participants exposed to regular lighting only, and that this effect is mediated by negative affect.

## 3. Study 1

The primary objective of study 1 was to test the general premise that weather variables can affect consumer spending. We wanted to see if and how weather might influence daily sales in a retail setting. In this study, we analyze secondary sales data from one independent retail store located in a large North American city. The store specialized in a single product line: tea and related accessories.

### 3.1. Method

*Data*: Our data consist of six years of daily sales and daily weather variables. The dependent variable in our model is the store's total daily sales. Our independent weather variables are: temperature (minimum, maximum and average), rain fall, snow fall, dry bulb, which is a measure of air temperature measured by a thermometer freely exposed to the air but shielded from radiation and moisture (minimum, maximum and average), humidity (minimum, maximum and average), wind direction, wind speed (minimum, maximum and average), barometric pressure (minimum, maximum and average) and sunlight. In addition, we controlled for season, the month, the day of the week, whether or not the store was open, and whether or not it was a holiday.

*Model used*: To test hypothesis 1, we estimated a random effects model, with the log of daily sales as the dependent variable (see below). A log transformation was used to normalize the sales data. This model has a random intercept to control for differences in sales across month and day (where day is treated as nested within month)

$$Sales_{ij} = a_{ij} + b_1 Temp_{ij} + b_2 Snow_{ij} + b_3 Sun_{ij} + b_4 Humid_{ij} + b_5 Sun_{ij} Temp_{ij} + b_6 Temp^2{}_{ij} + e_{ij}$$

$Sales_{ij}$ is the log of daily tea sales in month $i$ and day $j$; for $i=1, \ldots, 12$, $j=1, \ldots, 7$; $a_{ij}$ is the intercept for month $i$ and day $j$; *Temp* is the average temperature for the day; *Snow* is the total snow fall during the day; *Sun* is the total hours of sunshine for the day; $Temp^2$ is the quadratic term for the average temperature for the day; $e_{ij}$ is a random error term.


**Fig. 1.** The mediating role of negative affect in the effect of sunlight on consumer spending.

**Table 1**
Study 1—results of the random effects model.

| Variables | Coefficients | *t*-values | *p*-values |
|---|---|---|---|
| Intercept | 5.560 | 9.89 | < 0.001 |
| Temperature | −0.042 | −6.81 | < 0.001 |
| Snow fall | −0.042 | −2.11 | 0.035 |
| Sunlight | −0.259 | −3.69 | < 0.001 |
| Humidity | −0.010 | −4.24 | < 0.001 |
| Sunlight × Temperature | 0.029 | 5.08 | < 0.001 |
| Temperature × Temperature | 0.0002 | 4.86 | < 0.001 |

### 3.2. Results

The results are reported in Table 1. Consistent with hypothesis 1, we found that several weather variables had a significant effect on daily sales in this store over the six year time period. Specifically, we found main effects for average temperature ($b_1 = -0.042$; $t = -6.81$; $p < 0.001$), snow fall ($b_2 = -0.042$; $t = -2.11$; $p = 0.035$), sunlight ($b_3 = -0.259$; $t = -3.69$; $p < 0.001$) and a main effect for humidity ($b_4 = -0.010$; $t = -4.24$; $p < 0.001$). We also found an interaction effect between average temperature and sunlight ($b_5 = 0.029$; $t = 5.08$; $p < 0.001$) such that the effect of sunlight on sales is positive at lower temperatures and negative at higher temperatures. In addition, there is a nonlinear effect of temperature on sales. Specifically, there is a negative linear effect ($b_1 = -0.042$; $t = -6.81$; $p < 0.001$) and a positive quadratic effect ($b_6 = 0.0002$; $t = 4.86$; $p < 0.001$) of temperature on sales, suggesting that sales go up as temperature goes down but this effect on sales diminishes as temperatures become lower.[3]

### 3.3. Discussion

The results are compatible with previous research, which has found three general categories of weather effects. For example, consistent with the effects from the first category – i.e., bad weather can make going out to shop less attractive – we find that when it snows sales decrease. We also find effects that may be product specific—that is, sales of tea (and related accessories) decline when the weather is warmer and more humid. However, Persinger (1975) found that both humidity and precipitation can contribute to a negative mood and, therefore, these effects may be mood related.

Similarly, the results of study 1 indicate that the effect of sunlight, is conditional upon the average temperature—that is, the effect is captured by the interaction, which indicates that when temperatures are low, increased sunlight has a positive effect on tea sales. Although sunlight has been identified as a key variable in previous studies of the impact of weather on mood (Cunningham, 1979; Parrott and Sabini, 1990; Schwarz and Clore, 1983; Kripke, 1998; Stain-Malmgrem et al., 1998; Leppamaki et al., 2002, 2003; Lambert et al., 2002), the direction of this effect is consistent with both a product specific category explanation and a reduction in negative affect story. When it is already warm, higher levels of sunlight decrease tea sales.

Supporting hypothesis 1, study 1 provides strong evidence that weather can affect sales. However, the secondary data used in this study lacks measures of consumer mood, which are required to test hypotheses 2 through 4. In study 2, we use daily panel data to focus on the relationship between weather and mood, as well as the relationship between mood and consumption.

## 4. Study 2

### 4.1. Method

*Participants*: This study utilized 33 participants who were recruited from the general population of students at a large North American university. Participants were paid $100 to provide daily panel data by completing a web survey at the end of each day for twenty days in the month of March (average daily high 36°F).

*Data*: The daily survey included structured questions to measure participants' mood, spending on and consumption of tea and coffee, as well as individuals' total expenditures for the day. Building on study 1, this study adds a new product category (coffee) and in addition to measuring dollars spent we also ask participants for information on their actual consumption behaviors (i.e., not just how much they spend on tea and coffee, but how many cups of each beverage they drink). Respondents reported their mood using the PANAS scale (Watson et al., 1988) to capture positive and negative affect. The weather variables recorded during the collection of the panel data include the daily averages for temperature, humidity and barometric pressure, as well as the total hours of sunshine for the day.

### 4.2. Results

To test the prediction that weather, and sunlight in particular (H2), affect mood, factor scores for positive and negative affect were estimated using the pooled PANAS data. Then, the factor scores for positive affect and negative affect were each regressed on the daily weather variables, resulting in one model with positive mood as the dependent variable and one with negative mood as the dependent variable

$$Mood_{ij} = a_{ij} + b_1 Temp_j + b_2 Sun_j + b_3 Humid_j + b_4 Pressure_j + e_{ij}$$

$Moodi_i$ is the factor score for positive affect or negative affect for panel member $i$ on day of the week $j$; $a_{ij}$ is the intercept for panel member $i$ and day of the week $j$; $Temp_j$ is the average temperature for the day of the week $j$; $Sun_j$ is the total hours of sunshine for the day of the week $j$; $Humid_j$ is the average humidity for the day of the week $j$; $Pressure_j$ is the average barometric pressure for the day of the week $j$; $e_{ij}$ is a random error term for panel member $i$ on day of the week $j$.

Consistent with hypothesis 2, increased sunlight reduced negative affect ($b_2 = -0.042$; $t = -2.04$; $p = 0.042$). We also found that increased humidity reduced positive affect ($b_3 = -1.400$; $t = -2.02$; $p = 0.044$). No other effects of weather on mood were present in this data. The full results are reported in Table 2a and b.[4]

Only 25 purchases of tea or coffee were recorded over the 20 day period of the panel data. As a result of this small number of observations, we were unable to test hypothesis 1, 3 and 4 (i.e., the effects of weather and mood on consumer spending) with this data. Therefore, our analysis focuses on consumption patterns for which we have sufficient data points. Specifically, we ran two regression models with consumption (i.e., the cups of tea or coffee consumed per day) as the dependent variable and the mood variables (i.e., positive and negative affect factor scores) as the independent variables. We find no effect of mood on coffee consumption (NA: $\beta = 0.002$, $t = 0.060$, $p = 0.950$; PA: $\beta = -0.026$, $t = -0.870$, $p = 0.387$); however, negative affect does have a significant positive impact on tea consumption (NA: $\beta = 0.034$, $t = 2.020$, $p = 0.040$). The effect of positive affect on tea

[3] We used the Bayesian Information Criteria to determine which interaction and quadratic terms to include in the model.

[4] We tested for non-linearity of the weather related variables; however, no significant quadratic effects were found.

**Table 2**

| Variables | Coefficients | *t*-values | *p*-values |
|---|---|---|---|
| *(a) Study 2—the influence of weather on positive affect* | | | |
| Intercept | 3.032 | 1.91 | 0.056 |
| Temperature | −0.002 | −0.35 | 0.729 |
| Sunlight | −0.018 | −0.99 | 0.322 |
| Humidity | −1.40 | −2.02 | 0.044 |
| Pressure | −0.021 | −1.37 | 0.173 |
| *(b) Study 2—the influence of weather on negative affect* | | | |
| Intercept | 0.041 | 0.02 | 0.983 |
| Temperature | 0.008 | 1.04 | 0.297 |
| Sunlight | −0.042 | −2.04 | 0.042 |
| Humidity | 0.007 | 0.37 | 0.710 |
| Pressure | −0.913 | −1.14 | 0.256 |

**Table 3**
Study 2—the influence of weather on sales.

| Dependent variables | Independent variables | Coefficients | *t*-values | *p*-values |
|---|---|---|---|---|
| Number of cups of tea | Intercept | −0.792 | −0.94 | 0.347 |
| | Temperature | −0.0002 | −0.06 | 0.952 |
| | Sunlight | 0.006 | 0.62 | 0.539 |
| | Humidity | 0.034 | 0.10 | 0.924 |
| | Pressure | 0.001 | 1.21 | 0.225 |
| Tea volume | Intercept | −8.775 | −0.54 | 0.589 |
| | Temperature | 0.037 | 0.60 | 0.552 |
| | Sunlight | 0.009 | 0.05 | 0.961 |
| | Humidity | 2.746 | 0.40 | 0.687 |
| | Pressure | 0.105 | 0.69 | 0.488 |
| Coffee | Intercept | −1.389 | −1.20 | 0.233 |
| | Temperature | −0.002 | −0.41 | 0.679 |
| | Sunlight | 0.014 | 1.13 | 0.259 |
| | Humidity | 0.128 | 0.26 | 0.793 |
| | Pressure | 0.016 | 1.50 | 0.135 |

consumption was not significant (PA: $\beta = -0.026$, $t = -0.870$, $p = 0.387$) (Table 3).

### 4.3. Discussion

Study 2 uses consumer panel data that includes measures of mood, and thus, addresses a limitation of study 1. Specifically, the key finding of study 2 is that sunlight reduces negative affect, which supports hypothesis 2 and replicates the effect of sunlight on negative affect that has been documented in prior research (Kripke, 1998; Stain-Malmgrem et al., 1998). In addition, we find that humidity decreases positive affect, which is also consistent with prior work (Sanders and Brizzolara, 1982).

Spending on tea and coffee was unexpectedly too infrequent in this data set to allow us to test hypotheses 1, 3 and 4. Interestingly, however, we did find that as negative affect increased the consumption of tea also increased. In study 1, although we did not measure mood, the results were consistent with the expected mood congruency effect—that is, people tend to *buy* more tea when they were in a better mood. In study 2, we observe what appears to be a mood regulation effect—that is, people tend to *drink* more tea when their mood is worse (i.e., negative affect is higher). Study 3 allows us to more directly test the impact that sunlight and mood have on spending in a controlled laboratory environment. We discuss our results in terms of these two types of effects – i.e., mood regulation and mood congruency – in more detail in the general discussion.

Overall, the results of study 2 provide further support for our theoretical model and, in particular, the critical link between sunlight and negative affect (H2). However, the panel data has its own limitations. First, these data were collected in an environment where significant noise was present. Second, the measure of mood was only recorded once at the end of the day and not at the time of the spending or consumption decisions. Third, the lack of spending data did not allow us to test hypotheses 1, 3 and 4. Fourth, because exposure to sunlight was not manipulated, we cannot claim strong support for the causal effect on mood predicted by our model (Fig. 1). Nevertheless, studies 1 and 2 provide converging evidence that is consistent with our model using two different data sets that were developed with two distinct methods. In study 3, we again test the propositions of our model, this time using a third method (i.e., a laboratory experiment). Importantly, study 3 allows us to directly test hypothesis 4 – i.e., negative affect mediates the effect of sunlight on consumer spending – in a controlled environment where exposure to (artificial) sunlight is manipulated and mood is measured at the time the spending decision is made.

## 5. Study 3

Studies 1 and 2 indicated that sunlight is the weather variable that appears to have the predominant effect on both mood (i.e., negative affect) and consumer spending. Therefore, study 3 focuses on sunlight and manipulates participants' exposure to artificial sunlight using a specially designed "sun lamp." In addition, study 3 extends the product categories that are investigated beyond tea to include a variety of common consumer products (i.e., orange juice, a one-month gym membership, an airline ticket and a one-month newspaper subscription). We measure positive and negative affect after exposure to the artificial sunlight and immediately before participants express their willingness-to-pay for each of these products.

### 5.1. Method

*Participants*: This study was completed by 78 students at a large North American university. Five participants were removed because they were identified as outliers: their willingness to pay for a product was greater than three standard deviations from the mean.

*Procedure*: In this experiment, sunlight was manipulated with a sun lamp in a between-subjects design. The sun lamp was a desk lamp that was designed to produce light very similar in wave length to natural sunlight. Participants were randomly assigned to either a room containing a sun lamp, or to a room without a sun lamp. The sun lamp's location was counterbalanced between the two rooms—i.e., it was located in each room for approximately half of the time. This was done to control for the effects of any potential particularities associated with the two rooms.

Once participants were randomly assigned to an experimental condition, they were asked to read a short document (a review of English literature written during the time period from 1660 to 1689). Reading this document took, on average, 20 min. Participants were then asked to complete the PANAS mood scale and finally responded to open ended questions eliciting their willingness to pay for five products: green tea, juice, a gym membership, an airline ticket and a newspaper subscription.

*Data*: The dependent variable was measured by asking participants how much they would pay for a certain quantity of the product in question. Specifically, participants were asked how much they would be willing to pay for (1) 24 tea bags of Lipton's Green Tea; (2) a 2L carton of orange juice; (3) an one-month gym membership; (4) an airline ticket; and, (5) an one-month

newspaper subscription. These products were chosen because they are thought to be relevant to the student participants. In all cases, participants' mood was assessed using the PANAS mood scale (Watson et al., 1988), which provides measures of both positive and negative affect.

### 5.2. Results

First, consistent with hypothesis 1, we find that sunlight has a significant positive effect on willingness-to-pay (see Table 4) for all five products. Second, consistent with hypothesis 2, we find that sunlight has a significant negative effect on negative affect ($\beta = -2.94$; $t = 2.99$, $p = 0.004$), but no significant effect on positive affect ($\beta = 0.57$; $t = 0.35$, $p = 0.731$).

Next we test the effect of negative affect on spending (H3) and the predicted mediating role of negative affect in the relationship between sunlight and willingness to pay (H4). The results reported in Table 5 provide strong support for hypotheses 3 and 4. The results indicate that for all five products the effect of sunlight on willingness to pay is mediated by negative affect (Baron and Kenny, 1986). Moreover, in all cases the mediation is partial, as the effect of sunlight on willingness to pay is still significant after controlling for negative affect. However, the size of the coefficient for sunlight is substantially reduced after controlling for negative affect.

### 5.3. Discussion

As recommended by Winer (1999), we have employed three different methods and types of data in an attempt to triangulate the effects of weather on consumer spending and to establish the external validity of findings from our laboratory experiment. Our experimental design allows us to demonstrate a cause-and-effect relationship between exposure to sunlight and an increased willingness to pay for common products. This finding builds on and complements the results of studies 1 and 2. In addition, study 3 extends our results to five products categories, all of which provide strong support for our model.

## 6. General discussion

The results of the studies reported in this paper provide evidence of how weather can impact consumer spending. We find that temperature, humidity, snow fall, and, especially sunlight, can affect retail sales. In addition, the panel data replicate the general result of previous research, which found that sunlight affects mood (Cunningham, 1979; Parrott and Sabini, 1990; Schwarz and Clore, 1983), while simultaneously demonstrating that reductions in negative affect are associated with higher levels of consumption and spending. Also, we found a causal effect of sunlight on willingness to pay and demonstrated that the effect was mediated by negative affect.

Our finding that the effect of sunlight on consumption is mediated by negative affect is an important extension of prior theories that found a more positive mood facilitates spending (Donovan et al., 1994; Golden and Zimmerman, 1986; Sherman and Smith, 1987; Spies et al., 1997; Underwood et al., 1973). Specifically, we find that although some weather variables such as humidity may have an impact on mood through positive affect, only negative affect has an effect on consumer spending. This result provides further insight into the underlying psychological mechanism and, based on prior SAD research (Lambert et al., 2002), suggests a possible neuro-chemical basis for this effect (i.e., serotonin). This opens the door for future research to dig deeper into the specific link between weather based changes in mood and consumer spending.

This research also contributes to the literature on the influence of store atmosphere on consumer shopping behavior. Regarding store atmosphere, research by Kotler (1973) indicates that consumers respond to the "total product", and that a significant component of the total product is the place where the product is bought or consumed. In fact, the store atmosphere could be more

**Table 4**
Study 3—willingness to pay for products in sunlight and no sunlight conditions.

| Products | Sunlight condition (mean willingness-to-pay in $) | No sunlight condition (mean willingness-to-pay in $) | *t*-values | *p*-values |
|---|---|---|---|---|
| Green tea | 4.61 | 3.35 | 2.36 | 0.021 |
| Orange juice | 3.51 | 2.90 | 2.19 | 0.032 |
| Gym membership | 41.67 | 32.89 | 2.07 | 0.042 |
| Airline ticket | 517.98 | 400.00 | 2.20 | 0.031 |
| Newspaper subscription | 17.79 | 11.41 | 2.30 | 0.024 |

**Table 5**
Study 3—results of Barron and Kenny (1986) and Sobel (1982) mediation tests.

| Products | Sunlight on WTP for product | NA on WTP for product | PA on WTP for product | Impact of sunlight on WTP controlling for NA | Sobel test |
|---|---|---|---|---|---|
| Green tea | 1.26** | −0.15** | 0.034* | 0.12** | 1.98** |
| Orange juice | 0.62** | −0.10** | 0.027* | 0.08** | 2.18** |
| Gym membership | 8.78** | −1.21** | 0.081* | 1.00** | 1.98** |
| Airline ticket | 117.98** | −15.67*** | 5.71* | 12.82** | 2.01** |
| Newspaper subscription | 6.38** | −0.86*** | 0.29* | 0.71** | 2.08** |

Numbers in the table represent beta-coefficients; for the Sobel test, numbers represent *z*-values.
NA refers to negative affect; PA refers to positive affect.

* $p > 0.05$.
** $p < 0.05$.
*** $p < 0.01$.

influential than the product itself in the purchase decision (Kotler 1973, p. 48). Lighting is considered to be an important component of the store atmosphere, as a more appealing store with better-illuminated merchandise could entice shoppers to visit the store, linger, and perhaps even make a purchase (Summers and Hebert, 2001).

In the store atmosphere literature, the dominant theoretical model, the Mehrabian and Russell (1974) (M–R) model of approach–avoidance behavior, posits that the combined effects of pleasure, arousal and dominance influences people's behaviors in shopping environments. Regarding lighting, the M–R (1974) model theorizes that brighter lighting increases pleasantness and arousal, and that the combination of pleasantness and arousal will positively influence consumers' shopping behaviors. Although few empirical lighting studies have been conducted (Areni and Kim, 1994; Summers and Hebert, 2001), these studies have supported the M–R (1974) model of approach–avoidance behavior. For instance, Areni and Kim (1994) studied the impact of in-store lighting on shopping behavior utilizing a sample of 171 wine store consumers over a 16-night period. Lighting was manipulated to be "soft" on eight different evenings by replacing some of the store's existing lamps with lower-wattage lighting. On the eight remaining evenings, lighting was manipulated such that it was "bright" by replacing lamps with higher-wattage lighting. Results of this research show that consumers examined and handled significantly more items under "bright" lighting conditions than under "soft" lighting conditions.

Summers and Hebert (2001) tested the influence of lighting on consumers' approach behavior by installing supplemental lighting in two hardware stores. The lighting treatment was alternated each Friday and Saturday for 8 h/day per display. The results of this study indicate that lighting influences consumer approach behavior, as consumers touched, and picked up more items when additional lighting was present. In addition, consumers spent more time at displays under the on treatment than the off treatment. Overall, the results of these studies suggest that the observed effect of lighting on consumer behavior is attributed to arousal and pleasure. However, our results suggest a mechanism not captured by the M–R (1974) model. Specifically, we find that the mitigation of negative affect can explain the positive effect of lighting on shopping behavior. Furthermore, we show that the positive influence of lighting, caused by the mitigation of negative affect, actually influences consumer spending, while Summers and Hebert (2001) and Areni and Kim (1994) do not measure consumer spending.

*Managerial implications*: The weather is not under management's control; yet, retailers must respond to changes in the weather on a regular basis. Prior research has demonstrated that weather can affect store traffic and complicate staffing decisions (Agnew and Thornes, 1995; Parsons, 2001; Steele, 1951). It can also drive consumers towards some products and away from others—e.g., ice cream when its hot and oatmeal when its cold (Harrison, 1992). In addition, retail distribution networks, which have been designed for efficiency, tend to struggle in the face of unexpected adverse weather conditions that can range from relatively minor regional storms to global disruptions from climate change and volcanic activity (e.g., Koetse and Rietveld, 2009; Prater et al., 2001; Stecke and Kumar, 2009). As a result, retailers are often forced to respond to the effects of weather in a reactive, rather than proactive manner.

In this paper, we provide compelling evidence that weather variables can also affect consumers' internal states, which then influence their spending decisions. Specifically, we find that sunlight can reduce negative affect that, in turn, increases consumer spending. In addition, we have demonstrated that such affects occur with both natural and artificial sunlight. These findings build on prior research – which has demonstrated the influence that store atmospheric variables such as scent and music have on consumer spending (e.g., Bruner, 1990; Morrison et al., forthcoming) – and imply that one key weather variable may be proactively managed by retailers. For example, our results suggest that retail stores could selectively increase lighting levels on bad weather days in order to reduce negative feelings, which, in turn, should help increase sales. When the weather is already good, consumers' negative feelings will already tend to be low.

In addition, our results suggest that stores incorporate natural lighting (i.e. daylight) and/or alter their lighting such that it closely resembles sunlight, in order to reduce consumers' negative affect and increase sales. Such greater use of natural lighting has benefits for employees (Edwards and Torcellini, 2002) and should also lead to significant cost savings. In fact, for some buildings, over 90% of lighting energy consumed can be an unnecessary expense of excessive illumination (Hawken, 2000). Thus, turning off some electric lights when sufficient daylight is available should help save on lighting energy costs. Recent research has shown that daylight can introduce large energy savings in single-story commercial buildings, especially when it enters through the top of the building (Hesong et al., 2002). Furthermore, because daylight introduces less heat into a building than the equivalent amount of electric light, cooling costs can be significantly reduced.

*Limitations and directions for future research*: One limitation of our work is that study 2 and study 3 were both conducted during the cooler half of the year. The main effects of sunshine which we observed might not generalize to other times of the year when temperatures are warmer and negative affect is less prevalent. Indeed, we found an interaction effect between temperature and sunlight in study 1, which suggests that the effect of more sunlight on retail sales becomes negative when the weather is already warm (e.g., during the summer). Second, the evidence that negative affect mediates the effect of weather on consumer behavior is only available for sunshine. However, our study 1 analysis of the retail stores' sales found other effects of weather variables that might also be accounted for by their effects on mood. The research on weather effects has used various measures of mood, but it includes some results that are consistent with the negative effects we found for humidity and snow fall (precipitation) on retail sales. Additional research, is needed to examine whether the effects of these weather variables on consumer behavior are also mediated by mood.

Similarly, our predictions were motivated by a stream of research that has found that as consumers' moods become more positive, they spend more money (Spies et al., 1997; Underwood et al., 1973). In studies 1 and 2, we find that as sunlight reduces negative affect – and thus consumers' moods become more positive – consumers do tend to be willing to spend more. In study 2, however, we find that lower negative affect is correlated with more cups of tea being consumed. This finding is consistent with prior work on mood regulation (Bruyneel et al., 2009; Kivetz and Kivetz, 2008). For example, in contrast to the work cited above, prior research has found people in a negative mood tend to self-gratify or self-reward through consumption and purchasing more than controls (Thayer et al., 1994; Hadjimarcou and Marks, 1994; Gardner and Scott, 1990; Garg et al., 2007).

Recently, Kivetz and Kivetz (2008) have proposed that these conflicting results can be explained by two distinct mood mechanisms: (1) mood congruency, which states that people respond in accordance with their mood; and, (2) mood regulation, which states that people try to manage their mood. They argue that the psychological distance between individuals and the consequences of their actions and decisions is an important moderator of the impact of mood. Specifically, they contend that

mood congruency is most likely to be observed in decisions with psychologically distant outcomes, while mood regulation is more likely to occur when outcomes are proximal to the self and easy to experience. Two of the studies reported in this paper focused on psychologically distant outcomes—that is, willingness to pay (study 3) and the purchase of products to be consumed in the future (study 1). The results of both of these studies are consistent with mood congruency. In study 2, which looked at the psychologically proximate consumption of tea and the results were consistent with mood regulation. Additional research is required to improve our understanding of the opposing nature of these two types of effects.

Finally, future research should also investigate the relationship between weather, mood and the effectiveness of in-store promotional activities. One possibility is that promotional activities that temporarily reduce margins are less necessary when the weather is good and customers already have lower levels of negative affect, which increases willingness-to-pay.

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