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Weathering the preschool environment: affect moderates the relations between meteorology and preschool behaviors

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The goal of this study was to examine the relations among various meteorological conditions, affective states and behavior in young children. Results from past research have revealed many weather effects on behavior and emotions with adult samples. However, there is a paucity of empirical evidence to support this link with children. Thirty-three mothers were asked to rate their children (age 36–70 months) for a one-month period to assess positive and negative affect. Teachers completed questionnaires for the same period to assess internalizing (e.g. anxious), externalizing (e.g. aggressive) and prosocial (e.g. helping) behavior, and data were collected for various weather conditions. Pearson correlation analyses revealed many associations between weather and children's internalizing, externalizing and prosocial behavior. Furthermore, using a moderated model approach, the interactions between weather (temperature, humidity and amount of sunshine) and children's affect (positive and negative) were examined in the prediction of social adjustment in preschool. The overall pattern of results revealed that favorable temperature and an increased amount of sunshine promote positive social behaviors in children who are prone to higher levels of negative affect. However, the results also suggest that higher humidity is associated with decreases in prosocial behavior and increases in externalizing behavior in children who typically exhibit positive social adjustment. Findings are related to issues surrounding family functioning, classroom management and peer relations.

Keywords: *Meteorological effects; Preschool behaviour*

Introduction

Researchers across many disciplines have suggested that weather is associated with emotions, mood and behavior in adulthood. For example, Seasonal Affective

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Disorder has been linked to depression, anxiety and an overall negative emotional state (Wilson, 2002; Rohan & Sigmon, 2003; Soames, 2003). However, researchers have spent very little time exploring the link between meteorology and children's affective and behavioral states.

Characteristics intrinsic to children, such as negative emotions (e.g. high negative affect), have been linked to internalizing and externalizing problems in children (Caspi & Silva, 1995; Caspi *et al.*, 1995). And, there are many environmental variables that play a significant role in children's emotions and behavior. For example, parenting (Baumrind, 1978; Paterson & Sanson, 1999) and teacher practices including degree of certification (Coplan *et al.*, 1999) have been found to influence childhood behavior and emotions. However, a variable that is commonly overlooked as a possible associate of child behavior is the weather, even though for centuries researchers and laypersons alike have suggested that there is a link between current weather patterns and human behavior. Indeed, when we think about our own behavior, we may attribute sunny days to a better disposition, or cloudy, rainy days with depressed affect. Rosen (1979) and Sullivan (1976) have suggested that there is recorded evidence of such a connection. In fact, as far back as the age of Hippocrates, there has been mention of weather and its effects on species. Until recently much of the assumed associations between the weather and human behavior have been based primarily on observation and intuition.

A majority of the relevant research to examine these relations comes from studies associated with biometeorology, or the study of the atmosphere and life processes (Essa *et al.*, 1990). Furthermore, much of these relations focus on health-related issues and fail to explain common, everyday affect and behavioral change that might be mitigated by particular current weather patterns. Of the research available, only a scattering offer insight into the association between weather and children's affect to predict children's behavior. As a result, there is little knowledge pertaining to the direct relations between various aspects of the weather and the development of children. Furthermore, there have been no published studies to date that have attempted to look at the interaction between weather and mood in the prediction of children's behavior. As such, the goal of the present study was to explore these relations.

Weather and human behavior

The current literature linking weather with sociobehavioral or socioemotional change in childhood is extremely limited. Within the adult-based meteorological literature, researchers have explored the relations between weather and physical behaviors focusing on aggression and related constructs (Friedman & Becker, 1965; Cyr, 1985; Matlin, 1995), as well as beliefs about future weather conditions and current human responses (Rind, 1996, 2001). Furthermore, Bell (1992) postulated that the relation between temperature and aggression follows an inverted U association. This has been termed the negative affect escape model. There is strong empirical support for the hypothesis that aggression increases with temperature only up to a certain point (around 85°F), after which the aggressor becomes consumed with escaping the

uncomfortable situation (Baron, 1977; Ganjavi *et al.*, 1985; Anderson, 1987; Bell 1992; Cohn & Rotton, 1997). The impetus for many of these research studies involves the increase in aggressive behavior during warm summer months or in geographic locations where the ambient temperature remains high for prolonged periods of time.

Other researchers have indicated that asocial activity may be associated with weather variables. For example, positive relations between temperature and assault, homicide and domestic complaints, as well as positive correlations between monthly mean temperature and rape have been reported (Cohn, 1990a, 1990b). It has been documented that assaults peaked in August and were the lowest in December (Cohn, 1990b). One may conclude from this that warmer temperatures are associated with increased likelihood of criminal activity. Consistent with this speculation, Lester (1987) reported that homicide rates were higher in the Southern states than in the Northern states.

Changes in the environment have also been linked to other antisocial behavioral tendencies (Friedman & Becker, 1965; Cerbus & Dallara, 1975; Banziger & Owens, 1978; Raps & Stoupel, 1992; Barker *et al.*, 1994; Stoupel, 1999; Yan, 2000; Rotton, 2001). It has been reported that suicide increases with rises in barometric pressure and decreases in wind, drug addiction increases with greater changes in warm and cold fronts, and psychiatric admissions increase with warmer ambient temperatures. However, our knowledge about the relations between environment and affect is extremely limited.

Weather and affect

'When it's a sunny day people feel more energetic' or 'overcast days make people feel more lazy and depressed' are commonly believed folklore. Plausibly, the relation between weather and behavior could be moderated through the effects of people's affective states. Empirically, there has been little research to date to examine such an interaction. However, direct linear relations have been found between positive and negative moods, and particular weather variables in adult samples.

For example, lower barometric pressure, temperature and humidity have all been linked to more positive moods (Whitton *et al.*, 1982). Furthermore, lower physical energy levels, lower social interest and positive affect have been predicted by higher temperature, levels of humidity and barometric pressure (Sanders & Brizzolara, 1982). In a study by Persinger and Levesque (1983), temperature, relative humidity, wind speed, sunshine hours, barometric pressure, geomagnetic activity (i.e. the earth's magnetic activity) and precipitation were examined with respect to mood. Results indicated that changes in barometric pressure and sunshine hours were correlated with mood scores. Most notably, 40% of mood evaluations could be accounted for by a combination of meteorological events. In another report, mood was more positively evaluated when there was low humidity, high barometric pressure and cooler than average temperature (Goldstein, 1972). Also, Howarth and Hoffman (1984) examined a number of weather variables in relation to many different dimensions,

including concentration, cooperation, anxiety, aggression, depression, fatigue and optimism. The major finding in this study was that humidity had the greatest effect upon all of these dimensions.

There is a consistency of results within the majority of these studies. In all, it seems that high humidity is associated with negative moods and emotions, and lower temperature and more hours of sunshine are related to positive mood. These results coincide with a common belief that comfortable or 'good' weather is related to positive moods. In other words, 'good' weather seems to induce better moods.

Weather and social adjustment in childhood

The relations between weather and the social and emotional well-being of humans have been primarily examined in adult samples. Studying children in this same context could have potentially wide-reaching implications for parenting and teacher practices, as well as issues surrounding social, academic and peer relationship development. For example, Howarth and Hoffman (1984) reported that high humidity levels and low barometric pressure may negatively affect children's ability to concentrate in the classroom, and Clarke (1967) found that delinquent acts are directly related to meteorological fluctuations such as daylight hours, temperature and sunshine.

In one of the few published studies to examine the relationship between environmental conditions and preschool behavior, Essa *et al.* (1990) found that over a five-week period children showed increased interactions with in-class materials during times when the weather was stable. However, when the weather was inclement the children interacted more with peers and adults. It seems that during poor weather patterns, children sought out the security of social interactions with known peers and adults (Essa *et al.*, 1990). Although affect was not the focus of this study, it is possible to infer that poor weather was associated with children's affect, which in turn prompted behaviors associated with affiliation. Similarly, favorable weather may have prompted feelings of confidence and security that lead children to feel less threatened by the environment and more able to play independently.

The results from a recent study by Lagacé-Séguin and Coplan (2001) help support these speculations. In a quasi-longitudinal study to examine children's emotions over a 33-day period, it was found that various specific positive emotions were related to calmer and more pleasant weather conditions (e.g. a greater amount of sunshine was paired with an increased feeling of enthusiasm and emotional strength). Furthermore, inclement weather had a positive association with negative mood variables (e.g. a higher level of relative humidity was paired with a higher level of irritability). To date, this study is one of the few that focuses on how children's emotional states may be related to a variety of weather patterns.

Weather, affect and social adjustment

There are various possible mechanisms that may explain the relation between weather and the social adjustment of children. To begin with there may be a direct causal link

between these variables. In this case, weather would directly affect internalizing (e.g. anxious and withdrawn behaviors), externalizing (e.g. aggressive and hyperactive behaviors) and prosocial (e.g. helping behavior) behavior of children. However, it is conceivable that weather and children's behavior are associated with an individual's current affective state. It may be that weather interacts with a child's current affective state to predict social adjustment. This theory was the main focus of the current research.

To reiterate from a previous section, there have been a few studies that have examined the contributions of weather and mood (separately) in the prediction of aspects of social adjustment in childhood. However, there has been little attempt to examine the possible interactions between weather and affect in the prediction of anxiety, aggression and helping behavior in childhood. The objective of examining these relations is to augment the current research to include findings that describe how mood moderates the relation between weather and behavior.

The present study

Because there is a paucity of research to examine the impact of weather on children's affect and behaviors, this study sought to examine a population of children between the ages of three and six years. This research was designed specifically to complement and extend the current knowledge in the area by: (1) exploring children's affect and behaviors in relation to the environment; (2) examining the weather–affect–behavior associations in a cooler climate rather than the traditional warm climates in past research studies; and (3) to examine a moderated model to explain the interactions between weather and affect in the prediction of social behavior.

The first hypothesis was that children's moods and behaviors would be significantly associated with weather variables. Specifically, based on a review of the relevant literature, it was predicted that negative affect and internalizing and externalizing behavioral problems would be associated with inclement weather, and positive affect and prosocial behavior would be associated with more acceptable weather patterns. Second, it was hypothesized that there would be an interaction between weather variables and affective states in the prediction of anxious, aggressive and helping behavior in childhood. Because of the lack of research in this area, these hypotheses are purely exploratory in nature. Intuitively, it was expected that higher positive affect in children may act as a buffer from the negative influences of poor weather conditions while those children with lower negative affect may be more influenced. It was also suggested that certain weather patterns may increase the possibility that children prone to negative affect may not experience the expected outcomes associated with a depressed affective state.

Method

Participants

The participants in this study were 33 mothers and their children. Children were attending eight different preschool or daycare centers in a mid-sized Canadian city.

The children (18 males, 15 females) ranged in age from 36 months to 70 months (mean = 53.67, standard deviation = 9.04). Seven children came from single parent homes while 26 children lived in homes with married parents. The children came from middle-class and upper-class homes in which the parents' education levels ranged from secondary school to postgraduate education.

Measures

Affect.   Upon giving consent for their children and themselves to participate in the study, the mothers were given a booklet consisting of a demographics questionnaire and a one-month's supply of questionnaire pages. The daily questionnaires were the Positive and Negative Affect Scale (PANAS) (Watson *et al.*, 1988). The PANAS is a measure of mood in which 20 positive and negative moods are rated on a scale from one to five. As such, there are no statements describing each item, but rather each mood is presented (e.g. afraid) and the mother must rate her child on each of the 20 moods. These 20 items can be aggregated to form broad-band summary scores representing *positive* and *negative* affect. The scale can be used to assess children's moods on a daily or weekly basis, or as a one-time measure.

Watson *et al.* (1988) reported excellent test–re-test reliability for the positive ($r = 0.90$) and negative ($r = 0.87$) subscales. In this same study, the PANAS was also validated against other well-established scales. The negative subscale positively correlated with the Beck Depression Inventory (BDI) ($r = 0.58$) and the State Anxiety Scale (SAS) ($r = 0.51$). The positive subscale of the PANAS was negatively correlated with the BDI ($r = -0.36$) and the SAS ($r = -0.35$).

Social adjustment.   Teachers rated children's behavior problems and prosocial behavior using the Preschool Behavior Questionnaire (PBQ) (Behar & Stringfield, 1974) every school day for one month. This scale has well-established psychometric properties (Rubin & Clark, 1983; Hoge *et al.*, 1985) Based on results from subsequent research (for example Moller & Rubin, 1988; Coplan & Rubin, 1998) the broader two-factor solution was employed (internalizing problems and externalizing problems) and prosocial behavior was also included as an outcome variable (see Tremblay *et al.* [1992] for an explanation of the addition of a prosocial scale to the PBQ).

Procedures

Mothers were asked to complete the PANAS for their child at the end of each day for a span of one month during February and March (weekends were exempted from data analyses). The order of presentation for the various moods were counterbalanced over the month to avoid order effects.

For the present study the subscales of the PANAS were of interest. Of particular focus were the 10 positive and 10 negative affective states that, in many respects, closely resemble the basic emotions outlined by Plutchik (1980). Alpha coefficients

over the one-month period were α = 0.82 for the positive affect subscale and α = 0.87 for the negative affect subscale.

Teachers were asked to rate children's behavior problems and prosocial behavior using the PBQ (Behar & Stringfield, 1974) every school day for one month. The alpha coefficients over the month-long period were α = 0.76, α = 0.74 and α = 0.79 for the internalizing, externalizing and prosocial dimensions, respectively.

As a result of the structure of each scale used in this study, data will be analyzed separately by examining positive and/or negative affect, and internalizing and/or externalizing behaviors. While it may be intuitive to consider a single linear relationship between positive and negative affect (i.e. positive affect at one end, and negative affect at the other) or internalizing and externalizing behavior (i.e. internalizing behavior at one end, and externalizing at the other), it is not uncommon to present each of the aforementioned variables on its' own scale to represent varying degrees of influence (for example, Hart *et al.*, 1997; Rubin *et al.*, 2001).

Meteorological data

The data for the weather spanning the one-month period were collected from Environment Canada. A number of different weather variables were collected. These included: (1) humidity—as expressed as a percentage of the prevailing partial pressure of water vapor to the saturated water vapor pressure; (2) sunshine hours—average amount of sunshine per day in hours; and (3) temperature—in degrees Celsius (°C).

Results

Preliminary analyses

To begin with, a series of independent *t*-tests were performed to determine whether the affect or behavior variables differed with respect to gender. No significant gender differences were found, so the data were analyzed across the entire sample. Average scores (across the 33 children) were then computed for each of the 10 positive moods and 10 negative moods of each of the testing days in the one-month period.

Correlational analyses

Weather and mood.   A series of correlations were computed between the positive and negative affect subscales (over the one-month period) and each of the three weather variables (humidity, sunshine hours and temperature). Results are displayed in Table 1. In terms of overall positive and negative affect there were no significant correlations found.

Weather and behavior.   Another series of correlations was computed between the positive and negative affect subscales (over the one-month period) and each of the three social adjustment variables (internalizing, externalizing and prosocial behavior).

Table 1.   Correlations between weather variables and affect

Affect	Weather variables		
	Humidity	Sunshine hours	Temperature
Positive affect	−0.17	0.22	−0.23
Negative affect	0.02	−0.09	0.17

Results are displayed in Table 2. Results indicated that the more hours of sunshine, the less internalizing problems ($r = -0.41$, $p < 0.05$); the higher the humidity and less sunshine hours, the more externalizing problems ($r = 0.37$, $p < 0.05$ and $r = -0.36$, $p < 0.05$, respectively); and the less humidity and higher the temperature, the more prosocial behavior ($r = -0.35$, $p < 0.05$ and $r = 0.38$, $p < 0.05$, respectively).

Table 2.   Correlations between weather variables and behavior

Social adjustment variables	Weather variables		
	Humidity	Sunshine hours	Temperature
Internalizing	0.22	−0.41★	−0.22
Externalizing	0.37★	−0.36★	−0.31
Prosocial	−0.35★	0.27	0.38★

★$p < 0.05$.

Affect and behavior.   A final set of correlations was performed to examine the relations between affect and behavior (see Table 3). The higher the positive affect, the lower the externalizing problems ($r = -0.43$, $p < 0.05$). Also, the higher the negative affect, the higher the internalizing problems ($r = 0.37$, $p < 0.05$). Finally, the higher the negative affect, the lower the prosocial behavior ratings ($r = -0.39$, $p < 0.05$). A trend was noted between negative affect and externalizing problems ($r = 0.33$, $p < 0.10$), alluding to the association that the higher the negative affect, the higher the externalizing problems.

Table 3.   Correlations between affect and behavior

Affect	Behavior		
	Internalizing	Externalizing	Prosocial
Positive affect	−0.23	−0.43★	0.19
Negative affect	0.37★	0.33★★	−0.39★

★★$p < 0.10$ ★$p < 0.05$.

Regression analyses. In order to explore the interactions between weather and positive and negative affect in the prediction of indices of social adjustment, a series of regression analyses were computed following Cohen's partialed products technique (Cohen & Cohen, 1983). For each equation, weather variables (i.e. temperature, humidity, sunshine hours) and affect (i.e. positive or negative) were entered first, followed by the appropriate multiplicative interaction term (weather × affect). Separate equations were computed for each of the three adjustment outcome variables (i.e. internalizing, externalizing, prosocial behavior). In all, 18 equations were computed. The results are presented in Table 4.

A significant interaction was found between temperature and negative affect in the prediction of prosocial behavior. The interaction was explored by re-computing the regression analyses separately for groups of children scoring above or below the median in terms of negative affect. Results from follow-up analyses indicated that temperature was not significantly related to prosocial behavior among children exhibiting lower negative affect ($\beta = -0.23$, not significant), and significantly and positively associated with prosocial behavior among children with higher negative affect ($\beta = 0.37$, $p < 0.05$).

A significant interaction was also found between temperature and negative affect in the prediction of externalizing problems. Follow-up analyses indicated that temperature was negatively associated with externalizing problems among children with higher negative affect ($\beta = -0.26$, $p < 0.05$), and not associated with externalizing among children exhibiting less negative affect ($\beta = -0.08$, not significant).

Results also revealed a significant interaction between hours of sunshine and negative affect in the prediction of internalizing behaviors. Additional analyses indicated

Table 4. Results of regression analyses predicting indices of social adjustment from interactions between negative affect (NA) and positive affect (PA) and temperature (Temp), sunshine (SS) and Humidity (Humid)

Dependent variable	Interaction term (sr^2)	
Temperature	Temp × NA	Temp × PA
Prosocial	0.213*	0.008
Internalizing	0.004	0.001
Externalizing	0.192*	0.003
Sunshine	SS × NA	SS × PA
Prosocial	0.010	0.017
Internalizing	0.143*	0.001
Externalizing	0.002	0.001
Humidity	Humid × NA	Humid × PA
Prosocial	0.241*	0.003
Internalizing	0.004	0.001
Externalizing	0.002	0.291*

*$p < 0.05$.

that amount of sunshine was significantly negatively associated with internalizing problems for children with higher negative affect ($\beta = -0.36$, $p < 0.05$), and not associated with internalizing behavior among children with lower negative affect ($\beta = 0.06$, not significant).

A significant interaction was also found between humidity and negative affect in the prediction of prosocial behaviors. Results from follow-up analyses indicated that humidity was negatively associated with prosocial behaviors among children with lower negative affect ($\beta = -0.26$, $p < 0.05$), and not associated with instances of prosocial behavior among children exhibiting more negative affect ($\beta = -0.08$, not significant).

Results also revealed a significant interaction between humidity and positive affect in the prediction of externalizing problems. Follow-up analyses indicated that humidity was positively associated with externalizing problems among children with higher positive affect ($\beta = 0.26$, $p < 0.05$), and was not associated with externalizing among children exhibiting less positive affect ($\beta = 0.13$, not significant).

Discussion

The goals of the present study were to examine the relations between weather and children's moods and behaviors. First, simple correlations between all variables revealed some interesting and somewhat surprising correlations that support commonly held beliefs taken from popular folklore. Second, the interactive relations between weather and affect were explored in the prediction of social adjustment in preschool. Several interactions were found and follow-up analyses revealed some intriguing results regarding differential associations between the environment and moods for children with different levels of positive and negative affect.

Weather and social outcomes

There were many direct relations found between aspects of the weather and child outcomes. The current results are consistent with and extend the previous findings in the adult literature (Friedman & Becker, 1965; Cyr, 1985; Cohn, 1990a; 1990b). Specifically, there was a positive relation between humidity and externalizing problems but a negative relation between humidity and prosocial behavior. In addition, there were negative relations found between sunshine hours and internalizing and externalizing behavior problems in childhood. The overall pattern of results for the relations between weather and behaviors in childhood suggest that inclement weather (increases in humidity and decreases in sunshine hours) is associated with problematic behaviors in childhood. These results coincide with research by Essa *et al.* (1990) in which unstable weather patterns were found to increase the likelihood of children feeling uneasy in the classroom and extend past findings in the adult literature that suggest direct links between weather and human behavior such as higher temperatures leading to aggression and assaults.

There was also a significant relationship between temperature and prosocial behavior in preschool. Others have also noted relations between temperature and

behaviors (for example, Goldstein, 1972; Baron, 1977; Persinger, 1980; Sanders & Brizzolara, 1982; Whitton *et al.*, 1982; Cohn, 1990a; Anderson & DeNeve, 1992; Barker *et al.*, 1994). However, the majority of findings seem to suggest that rises in temperature are paired with aggressive acts and crime-related behaviors. There are several reasons that this discrepancy may have arisen. First, the current study is one of the only studies to date that has examined a child-aged population. The goals of a majority of past studies have been to examine the relations between crime and aggression and various weather patterns choosing to study samples of convenience (i.e. crime-related statistics, not instances of prosocial/altruistic acts). In the current study, ratings of behavior problems as well as instances of prosocial behaviors were recorded. Therefore, the purpose and methodology of this study differs substantially from past studies in the area.

To speculate further, a positive relation between temperature and prosocial behavior may be expected given the winter context of this study. It is entirely possible that increases in temperature in winter months would warm children up to levels that are more comfortable for engaging in prosocial behaviors. It must be kept in mind that this study was completed in winter months and the average temperature was −6.88°C, whereas most other studies have taken place in either spring or summer months, or in climates prone to extremely warm temperatures.

Weather and affect

There were no significant relations found between weather and the global aggregates of positive and negative affect. The lack of findings requires some explanation since it is known that meteorology may interact with our physiology to produce variations in affect. For example, Seasonal Affective Disorder has been associated with variations in daylight that influence norepinephrine levels and this may contribute towards mood dysregulation. Decreased norepinephrine levels are associated with low arousal and depression, and high levels are associated with mania and increased motor activity (Grilly, 1998).

Also, past research has found significant direct relations between various weather variables and specific subcomponents of positive and negative affect (for example, Lagacé-Séguin & Coplan, 2001). Specifically, significant positive relations have been found between temperature and a child's alert state and negative relations have been found between humidity and emotional strength and determination as well as between an alert state and average amount of sunshine per day. One obvious difference between this study and the current research is based on general purpose of each. Lagacé-Séguin and Coplan (2001) were interested in exploring specific elements of affect and related association with various weather variables, whereas the purpose of the current research was to explore global aggregates of positive and negative affect and related associations with the weather.

Furthermore, the lack of relations may be due to methodological issues. It can be speculated that significant relations may be evident if a different measurement technique was employed to collect information about children's affective states. In the

current study, maternal ratings of children's negative and positive affect were collected. It may be that observational data collected from inside the preschool class may provide more accurate instances of emotional expression. The current data may be confounded by maternal perception or maternal affect whereas observational data would be less likely subject to these influences. Other data collection techniques such as those that are typically routine in medicine may be more sensitive to changes related to the environmental change and therefore behavior and emotional changes associated with Seasonal Affective Disorder may not be directly observable in the current study.

Weather, affect and behavior

The results from this study add substantially to the current literature. Findings indicated interactions between aspects of the weather and affect in the prediction of child social adjustment. For example, among children who were rated as having higher negative affect, temperature was positively associated with child prosocial behavior in preschool, temperature was negatively related to externalizing behavior, and increased hours of sunshine was negatively related to internalizing problems. In concert, results from this study suggest that favorable weather may lead to behaviors indicative of good positive social adjustment in situations where child affect provides expectations of unfavorable outcomes. Research has shown that high negative affect in children has been associated with internalizing and externalizing problems (for example, Caspi *et al.*, 1995; Caspi & Silva, 1995). Results from this study support the idea that aspects of weather, particularly temperature and amount of sunshine, may actually act to temper the traditional outcome expectations of negative affect in childhood.

Findings also suggest that among children with low negative affect, humidity was negatively related to instances of prosocial behaviors. Furthermore, among children with high positive affect, higher rates of humidity lead to more externalizing problems. Past research has shown that a positive affective state is associated with better adjustment in childhood (for example, Bates *et al.*, 1991). Coupling this finding with the current findings it can be speculated that humidity may actually interfere with 'good' child behavior in children most likely to engage in these types of relations with their peers. In fact, in one instance the results suggest that humidity may actually promote aggressive behaviors from an unexpected child population. Interpretation of these findings suggest that high humidity serves to deter prosocial acts and encourage externalizing behavior from a population of children who otherwise may not be prone to engage in such behaviors. In the literature based on adult samples it is well known that humidity influences behavior problems (for example, Sanders & Brizzolara, 1982). However, Essa *et al.* (1990) did suggest that inclement weather lead children to seek the company of teachers and peers. But, the types of activities that children engaged in with teachers and peers are not clear, nor are the differential affective states of the children. The results from this study in concert with results from other suggest that further research needs to be completed with the intention of examining specific types of peer relations during variations in the environment.

Caveats and conclusions

The study described herein has filled a notable gap in the weather, affect and behavioral literature. The importance of examining weather variables and the interaction with children's moods to predict various social behaviors was clearly illustrated. Until now, relationships between weather and children's moods and behaviors have been predominately driven by anecdote. Findings arising from this research have far-reaching implications for researchers, teachers, parents and children alike. For example, drawing on the results of this study, teachers may be able to predict students' susceptibility to various weather patterns and foresee changes in behaviors linked to meteorological variations. Furthermore, parents may be able to use the information from this study to promote positive child behaviors in the face of changes in the weather that may be likely to provoke conduct problems. Moreover, this study may aid in the explanation of friendship and peer choice in childhood. Given that one of the elements that drive children towards or away from particular friendships or peer relations is behaviors of others, meteorological conditions may play a role in friendship formations. It can be speculated that children's behaviors and moods that function as the result of weather changes (i.e. inconsistency of behaviors and moods) may be predictive of poor peer relations.

However, some caveats need to be taken into consideration in the interpretation of the findings. Mothers rated their children's affect, which may infer that the data presented are maternal interpretations of children's affective states. There may be a correlation between maternal affective states and the mother's rating of her child's affective state. Future investigations could address this problem by having impartial observers provide naturalistic observational data of the young children's emotional responses. Alternatively mothers could complete a questionnaire to assess their affective states in order to determine the degree of concordance between the affective states of the mothers and that of the children. This would also control for the possibility that weather variables might be influencing mothers' moods as well, which in turn might be influencing mothers' ratings of their children. With this said, the findings of the current study are not to be diminished. Maternal reports of children's behavior are commonplace in social–emotional–behavioural research (for example, Tremblay *et al.*, 1992).

Future researchers may also want to examine the influence that the quality of preschool may have on children's moods. Although all participating preschools were deemed as high quality, it is possible that different learning environments may confound the relations between the environment, affect and behavioral adjustment in preschool.

Finally, three environmental variables were subject to data analysis in the current research study. Future research may choose to replicate this methodology and examine temperature, hours of sunlight, and humidity as associates of mood and behavior *or* extend the current findings by examining other meteorological variables such as barometric pressure and precipitation. Furthermore, atmospheric variables such as geomagnetic flux and moon phase are interesting elements that have only begun to

be understood by researchers as potential influences of affect and behaviors. It may be instructive to learn of the combined influences of these variables on the behaviors of young children. Future research should extend on these findings by exploring the relationship between children's behaviors and affective states during different seasons of the year since this study was only conducted during the winter months.

In all, the importance of considering how different environmental variables were related to indices of adjustment for children with differing levels of positive and negative affect was clearly illustrated. Future research will help to continue to unravel the complex associations between environment, child characteristics and social adjustment in early childhood and beyond.

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