

Original article

A relationship between temperature and aggression in NFL football penalties

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Abstract

Background: Increased ambient temperature has been implicated in increased physical aggression, which has important practical consequences. The present study investigates this established relationship between aggressive behavior and ambient temperature in the highly aggressive context of professional football in the National Football League (NFL).

Methods: Using a publicly available dataset, authors conducted multiple hierarchical regression analyses on game-level data (2326 games).

Results: The analysis revealed that temperature positively predicted aggressive penalties in football, and that this relationship was significant for teams playing at home but not for visiting teams.

Conclusion: These results indicate that even in the aggressive context of football, warmer weather contributes to increased violence. Further, the presence of the heat-aggression relationship for the home team suggests that the characteristics of interacting groups may influence whether heat would have an adverse effect on the outcome of those interactions.

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Keywords: Aggression; American football; Intergroup; Sports; Temperature

1. Introduction

Weather is an environmental characteristic that influences affect and cognition. In fact, researchers have shown that ambient temperature is the primary factor in this relationship.¹ The experience of warm spring weather is associated with increased positive affect and broadened cognition, while hotter summer weather is associated with decreased positive affect and frustration and winter weather associated with more depressive symptoms. A consequence of decreased positive affect in hot weather is an increase in aggressive acts of violence.^{2–4} Anderson and colleagues³ investigated rates of violent crime and property crime in the US over

a 45-year period and demonstrated more violent assaults with temperature increases, after controlling for population and age.

Several models have been explored in the literature to explain the relationship between temperature and aggression. The predominant model is General Aggression Model,^{5–7} which suggests there are combinations of inputs that impact the internal states of the individual (e.g., anger), such as environmental/situational factors and personal tendencies (e.g., poor self-control). These inputs then influence decision making processes that determine whether a behavioral outcome is aggressive. In this model, ambient temperature is an environmental input biasing both affect (e.g., irritation) and mental schemas toward aggression.

The importance of the heat-aggression relationship becomes more concerning, given the recognition of climate change and the possible impact of increased average global temperature on

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human interaction, with growing evidence linking warmer temperatures to intergroup conflict frequency.⁸ Also, given the continued growth of the human population⁹ and the known relationship between population growth, conflict, and warfare,¹⁰ an understanding of the characteristics such as heat that affect the nature of human violence is essential. An overview of potential effects of increasing global temperature on human society reveals several broad categories of negative consequence, including but not limited to increasing civil unrest, higher individual irritation, and an increasing tendency to perceive aggression in others.¹¹

Given the concern of increased intergroup conflict due to population increase and increased global temperatures, heat and aggression would be important to study in an intergroup context. Previous research on intergroup emotions and aggression have found that the primary predictor between individual endorsement of offensive actions towards outgroups is the perceived strength of the ingroup (e.g., size), although this relationship is mediated by reported experience of anger.¹² The rationale for this relationship is unclear, but it may be due to a rapid calculation that intergroup competition between members of social species makes necessary. As an example of this, ingroup chimpanzees are significantly more likely to act aggressive toward an outgroup intruder when the ingroup has the numerical advantage.¹³ Given that heat contributes to negative affective states such as anger, which mediates the ingroup strength and offensive action relationship, one could anticipate that the heat-aggression relationship is more pronounced for contexts where one group has more perceived support than the other group.

Researchers have extended the investigation of temperature and aggression to team sports, as they provided a unique and well-defined natural experiment. Highly competitive games involve precarious social relationships; therefore, ambient temperature is likely to influence behavioral outcomes during games. In baseball, as temperature increases, so does the number of batters struck by a pitch. Reifman et al.¹⁴ suggested that rising temperatures result in aggressive tendencies in players, leading to intentional aggressive throws by pitchers. Further research in baseball demonstrated that in even hotter conditions, if teammates have been struck by the opposing team's pitcher, pitchers are more likely to retaliate by hitting the batter with the ball, particularly with increasing number of teammates struck.¹⁵

The National Football League (NFL) football season is ideal for examining the heat-aggression phenomenon, as football is played in the colder fall, winter, and spring seasons, allowing for a wide range of available temperatures to explore the heat-aggression relationship. The variability in location is also important as weather turns cool in northern states earlier and temperatures are elevated longer in southern states.

More importantly, NFL football is a contact sport, which may be considered especially aggressive, as evidenced by the increased risk of traumatic brain injury^{16,17} and cognitive dysfunction¹⁸ following participation. Therefore, examining data from football games allows consideration and analysis of

the effect of ambient temperature on aggression in a heightened aggression setting, and allows investigation of whether high ambient temperature retains its influence to increase aggressive acts. Though football may be considered aggressive in general, combative penalties (e.g., unnecessary roughness) can distinguish between hostile (or affective) aggression, which may be sensitive to temperature, and instrumental or purposeful aggression.

The context of football allows for an investigation into the relationship between heat, physical aggression, and intergroup dynamics. Given the aforementioned findings on increased ingroup support contributing to aggressive action, football teams playing at home (high ingroup support) are more likely to commit acts of aggression against the opposing team, particularly under conditions of high ambient temperature as heat contributes to negative affective states such as anger. Furthermore, heat is more likely to contribute to aggression by influencing the internal state of home team players, who are more apt to experience territoriality and pressure because they perform on their own turf and before the home crowd.¹⁹ The present study investigates the issue by using football as the context to first verify whether the heat-aggression relationship exists, and then determine whether the relationship holds true for both home teams and away teams.

There is also some debate on whether the relationship between temperature and aggression is linear or non-linear.²⁰⁻²² There is some evidence that the relationship is curvilinear when the ability to escape both heat and social contact is taken into account. However, re-analyses of these data have primarily found a linear relationship, particularly during periods of high violence risk,²³ which suggests that in the high physical context of NFL football a linear relationship should be present between temperature and aggressive penalties.

The finding of increased aggression in higher temperatures would have significant implications for other aggression contexts where the ambient temperature varies. These contexts can include other aggressive sports such as rugby, but of more concern are those situations where lives are at stake, such as mass protests and warfare. Therefore, we predict that a significant linear relationship between temperature and aggressive penalties will be found, despite the already aggressive context of the sport, and that this relationship will hold true for home teams but not visiting teams due to the perceived ingroup support of home teams.

2. Methods

To explore the temperature and aggression relationship in football, the authors obtained publicly available, secondary data from the website Armchair Analysis.²⁴ It contained game-level data for all games in the NFL seasons 2000–2011. Variables included but were not limited to information on game-day temperature, points by home team and away team, number and type of penalties. Each game functioned as an independent unit of analysis, generating data for the variables of interest.

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