

# A Hot New Way to Measure Aggression: Hot Sauce Allocation

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Laboratory experiments investigating aggressive behavior have operationalized and assessed aggression in a variety of ways; however, these measures are often problematic because they do not create a situation in which participants perceive potential for real harm to come to the target, there is a risk of actual harm to the target, or they are too familiar to participants. To overcome these limitations, we developed a new method for measuring aggression, specifically, the amount of hot sauce administered to a target known to dislike spicy foods. We summarize a series of experiments assessing theory-based hypotheses regarding aggression in which this measure is employed. We then briefly consider the strengths and limitations of this new measure. *Aggr. Behav.* 25:331–348, 1999. © 1999 Wiley-Liss, Inc.

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**Key words:** measurement; methodology; aggression; displaced aggression; terror management theory; cognitive-experiential self-theory

## INTRODUCTION

Aggression is commonly defined by social psychologists as behavior intended to harm the individuals who are the objects of aggression [e.g., Baron and Richardson, 1994; Berkowitz, 1993; Geen, 1990]. Laboratory experiments are frequently employed to investigate the causes of aggression because specific factors thought to affect aggression can be independently manipulated and because the laboratory provides an environment in which aggressive behaviors can be assessed in a safe and ethical fashion [Baron and Richardson, 1994; Berkowitz, 1993].

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We recently developed a new method for measuring aggression to overcome limitations of other procedures. The purpose of this paper is to provide a detailed description of this methodology and to present the results of a series of experiments in which hot sauce administration was effectively utilized as a measure of physical aggression.

## **OVERVIEW OF EXISTING LABORATORY MEASURES OF AGGRESSION**

### **Verbal Assaults**

The verbal expression of hostility is one of the oldest and most common measures of aggression [e.g., Berkowitz, 1970; Berkowitz and Holmes, 1959; Cohen, 1955; Davitz, 1952; DeCharms and Wilkins, 1963; Doob and Sears, 1939; McClelland and Apicella, 1945; Wheeler and Caggiula, 1966]. In the typical procedure, participants are first exposed to some type of provocation (e.g., a confederate who prevents the participant from obtaining a goal) and are then given an opportunity to aggress through verbal statements, written comments, or formal evaluations of the target of their anger—often with the implication that the target will be harmed by the evaluations in some way. Although this procedure has the ethical advantage of eliminating physical harm to participants, it is limited to the extent that its validity depends on participants' genuine belief that their verbal expressions will actually harm the target. For example, if evaluations are made but participants do not believe that actual harm will come from their verbal assessments, then it is impossible to maintain that aggression has occurred [Geen, 1990]. Further, verbal evaluations may more accurately reflect "expressions of participants' current emotional arousal, liking for the victim, (or) general affective state" than actual aggression [Baron and Richardson, 1994, p 66].

To render verbal statements more overtly aggressive, several researchers have used offensive verbal statements as a measure of aggression [e.g., Goldstein et al., 1975, Richardson et al., 1994 (study 3), submitted]. For example, Richardson et al. [1994, study 3] developed a technique in which research participants sent messages varying in offensiveness to another person with whom they were purportedly competing on a reaction-time task.

Although this measure minimizes an obvious problem associated with more general verbal evaluations, it does not (and cannot) circumvent a basic limitation associated with all verbal measures of aggression, specifically, their dubious relationship to physical aggression. Just because someone insults a target does not mean they would attempt to inflict physical pain on them.

### **Ostensibly Harmful Attacks**

One of the most popular techniques for measuring physical aggression involves participants administering electric shocks to targets [e.g., Berkowitz, 1964; Buss, 1961; Hammock and Richardson, 1992a, 1992b; Taylor, 1967]. Typically, both the shock intensity and duration are recorded. This is probably the best existing measure of aggression because it clearly indicates an intent to physically harm the target. However, this approach has a number of disadvantages. First, it requires the researcher to acquire expensive and elaborate equipment. Second, the association of the shock paradigm with the Milgram obedience research presents problems with approval from university human subjects committees. Third, participants in shock paradigm studies (especially college students) are often too familiar with Milgram's obedience studies and are thus

unlikely to believe that any real shocks will ever be delivered—rendering this measure useless as an indication of aggression. Finally, as a number of researchers [Baron and Richardson, 1994; Hammock and Richardson, 1992b; Rule, 1974; Rule and Leger, 1976] have noted, many of the shock paradigms involve telling participants that the experiment is investigating the effects of punishment on learning, and the intensity of shock could be associated with intentions besides hurting the other (e.g., being a good teacher).

Several researchers have tried to overcome this final limitation by changing the procedure to a retaliation paradigm [e.g., Taylor, 1967]. In this procedure, participants are informed that they are engaging in a reaction-time task (with a confederate) and that the slower person on each trial will receive a shock (or, in other studies, a noxious noise where the volume and length of exposure can vary [e.g., Bushman, 1995]). Participants are allowed to select the intensity of the shock delivered to their opponents. Wins and losses are predetermined, and the participant receives a series of shocks during the course of the experiment. This procedure solves the problem of the ambiguity of participant intention associated with the learning paradigm, but, as Baron and Richardson [1994] note, several other problems are created. First, participants may view their behavior as competitive rather than aggressive (e.g., participants might give their opponents more painful shocks in an effort to slow them down on subsequent trials rather than to directly aggress per se). Second, participants must be exposed to a series of uncomfortable shocks, which may raise some ethical concerns and make approval from human subjects committees difficult.

In sum, although a variety of measures exist to assess aggression in laboratory settings, and each has its strengths and uses, each also has significant limitations. Accordingly, we sought to devise a new means to measure intent to physically aggress against another. Our goal was to provide an opportunity for people to engage in a behavior that could cause direct and unambiguous physical harm to another individual, while minimizing ethical concerns stemming from actual physical discomfort endured by participants during the procedure. Consequently, we created a procedure in which participants are required to determine the amount of hot sauce to be consumed by another person who purportedly does not like spicy foods.

## THE HOT SAUCE PARADIGM

The hot sauce paradigm requires manipulating some variable that is hypothesized to influence aggression and providing participants with an opportunity to aggress against a target by choosing the amount of extremely spicy hot sauce to be allocated to a fellow participant. Typically these manipulations have involved some form of threat or noxious stimulus. Previous research has demonstrated that participants are more likely to aggress against others who deliver a noxious stimulus to them [see, e.g., Baron and Richardson, 1994; Geen, 1990]. Consequently, in some experiments, participants read an essay purportedly written by a fellow participant that either violated or did not violate their cultural worldviews (e.g., self-reported liberal participants read an essay that claimed liberals or conservatives were ruining the country [McGregor et al., 1998 (study 1)]. In other experiments, participants are required to drink either a neutral or a noxious sample of juice that was purportedly prepared by another participant in the same experimental session [Lieberman and Greenberg, 1998; McGregor et al., 1998 (study 4)]. Participants in all studies then administer hot sauce to the “offending” tar-

get in the context of a study examining the relationship between personality and taste preferences.

The hot sauce measure has the advantage of being easily quantifiable, theoretically clear (insofar as participants' behavior could not be interpreted as competitive or in response to demand characteristics of the experiment), and at least to some extent ecologically valid in that spicy food has been recently utilized in both real world acts and media portrayals of aggression. For example, in the film "Mrs. Doubtfire," the character played by Robin Williams intentionally put an excessive amount of cayenne pepper on the food that was about to be eaten by a man romantically interested in his ex-wife. A similarly aggressive act occurred in a New Hampshire Denny's restaurant where a cook spiked the breakfast of two New Hampshire state troopers with Tabasco sauce [Associated Press, 1995; Milne, 1995]. After consuming the hot sauce, one of the officers reported that his mouth was burned, and the other experienced extreme discomfort in his stomach. The cook was arrested for assault. An eyewitness who reported seeing the cook put the Tabasco on the food said that the chef did not like police officers and had intended to harm the troopers [Associated Press, 1995]. Hot sauce has also been used in a number of reported child abuse cases [e.g., Associated Press, 1993; Brooks, 1992; Columbus (Ohio) Dispatch, 1992; Donahue, 1989; Martin, 1994; Serrano, 1989; "Thirty-nine," 1992] where parents have forced children to consume hot sauce directly or have laced their food with it. These incidents indicate that spicy food has been used in a variety of malevolent efforts to harm others and may thus provide a valid new measure of laboratory aggression.

### **Research Using the Hot Sauce Paradigm**

We conducted a series of studies in which we created a context where participants were either likely or not likely to act aggressively (based on social psychological theories) toward a target who they believed was another participant in the study. Participants were then given an opportunity to determine the quantity of a very spicy hot sauce to be given to the target knowing that the person did not like spicy foods and would have to consume the entire sample of hot sauce. We predicted that groups of participants who were likely to act aggressively would allocate significantly greater amounts of hot sauce relative to the other groups.

This assumption was tested in experiments examining hypotheses derived from two different theoretical perspectives that we felt would allow us to assess the validity of hot sauce allocation as a measure of aggression and at the same time advance our understanding of psychological factors that engender aggression, specifically, terror management theory [Greenberg et al., 1997; McGregor et al., 1998] and cognitive-experiential self-theory [Epstein, 1994; Lieberman and Greenberg, 1998].

**Terror management theory.** Terror management theory (TMT) [Greenberg et al., 1986, 1997; Solomon et al., 1991], based largely on the work of the cultural anthropologist Ernest Becker [1971, 1973, 1975], maintains that humans have both an instinctual drive for survival and sophisticated intellectual abilities that allow us to conceive of our own existence as well as our eventual death. Awareness of vulnerability and mortality is in conflict with our instinctive drive for survival and results in the potential for paralyzing terror in the individual. This terror is managed by a two-part cultural anxiety buffer: (1) a cultural worldview that imbues the world with order, meaning, and permanence—a set of beliefs that explains the origin of our existence (e.g., Creation-

ism vs. Big Bang), provides standards that allow one to attain a sense of personal value, and promises either literal immortality (such as the Christian belief of Heaven) or symbolic immortality (such as Babe Ruth, who has symbolically lived on after his death through his numerous athletic accomplishments and his candy bar); and (2) self-esteem—the sense that one is living up to culturally prescribed standards and is hence a valuable member of a meaningful universe in the service of ameliorating the anxiety that results from the uniquely human awareness of death.

According to TMT, a great deal of social behavior is directed toward the maintenance and defense of the cultural worldview, which is essentially a shared social construction rather than an absolute representation of reality. Consequently, the presence of others who share a similar cultural worldview reinforces faith in that worldview, increasing its effectiveness as an anxiety buffer. However, exposure to those who do not share a similar worldview is inherently problematic because the mere existence of different others undermines the faith with which one subscribes to the absolute validity of one's own cultural worldview, thus undermining its anxiety-buffering function and provoking defensive responses. Consistent with this claim, previous research has demonstrated that when people are asked to ponder their own death (mortality salience), they generally respond more favorably to those who share common beliefs and more negatively to those who do not (worldview defense). For a complete overview of this line of research see Greenberg et al. [1997].

TMT asserts that negative reactions to alternative worldviews can take the form of derogation (dismissing threatening worldviews), assimilation (convincing others to drop their perspective in favor of one's own), accommodation (actually incorporating portions of alternative worldviews so that they are no longer threatening), and the most extreme form of worldview defense—aggression (attack against people who hold alternative worldviews). Our research focused on this final worldview defense mechanism. Consequently, we predicted that participants would act aggressively and thus administer greater amounts of hot sauce when their mortality was made salient to them and they were confronted by a worldview threatening target than they would when mortality was not made salient or they were confronted with a target who did not threaten their worldview.

**Cognitive-experiential self-theory.** We have also used hot sauce as a measure of aggression in a study investigating the impact of rational and experiential cognitive processing on displaced aggression [Lieberman and Greenberg, 1998]. Cognitive-experiential self-theory (CEST) [Epstein, 1994] maintains that there are two modes of human information processing—an experiential mode and a rational mode. The experiential mode is quick, intuitive, and emotionally driven; the rational mode is deliberate, effortful, and analytic. Previous research in support of CEST has demonstrated that when individuals are in an experiential mode, they are more likely to rely on heuristic cues and fail to accurately process information presented to them. However, these errors in processing are reduced when individuals are motivated to think in a rational and analytic manner [for a review see Epstein, 1994].

We believed that the rational-emotional distinction would be very useful in understanding the underlying processes that foster displaced aggression—when people respond to provocation in an indiscriminate fashion as opposed to confining their aggressive responses to the provocateur. Specifically, Lieberman and Greenberg [1998] predicted that displaced aggression would occur when provoked individuals were in an experien-

tial mode because they would not consider who the target of their aggression is or ought to be. Displaced aggression would not occur when provoked individuals were in a rational mode because participants would rationally direct their aggression specifically at the provocateur.

Testing the hypotheses of TMT and CEST regarding aggressive behavior requires different methods of initial provocation. In most of the TMT studies [McGregor et al., 1998 (studies 1–3)] provocation occurs by presenting participants with a paragraph purportedly written by a worldview-threatening target. This manipulation requires a slightly more elaborate procedure than the alternative provocation method of having participants taste a noxious juice sample purportedly selected by a fellow participant [Lieberman and Greenberg, 1998; McGregor et al., 1998 (study 4)]. We will begin by describing the more complicated worldview threat manipulation procedure and, where appropriate, note how the juice sample paradigm differs. We will then briefly summarize the results of research based on these two theoretical perspectives.

## METHODS

### Procedure

After arriving at the laboratory in groups of four, participants<sup>1</sup> were told that they would be involved in two studies on personality.<sup>2</sup> The “first study” was described as examining personality and impression formation. Participants were told that their responses were anonymous and that throughout the experiment they would be identified by a three-digit participant number that appeared on all of their materials. Participants were directed to individual cubicles where they were asked to write a paragraph on a general topic such as their opinion of “politics in the United States” [McGregor et al., 1998 (studies 1 and 2)] or “the direction the country is heading in” [McGregor et al., 1998 (study 3)]. After several minutes, the experimenter entered the cubicle, collected the essays, and asked participants to complete a series of personality questionnaires. Embedded in a series of filler personality items was the mortality salience manipulation used in the TMT studies.

Specifically, participants in the mortality salience conditions were instructed as follows: “Please briefly describe the emotions that the thought of your own death arouses in you,” and “Jot down as specifically as you can, what you think will happen to *you* as you physically die, and once you are physically dead.” Participants in the mortality not-salient control condition were asked two open-ended questions about an aversive event other than death. For example, “Please briefly describe the emotions that the thought of your next important exam arouses in you” and “Jot down as specifically as you can, what you think will happen to *you* as you physically take your next exam, and once you are physically taking your next exam.”

After participants completed the personality questionnaires, the experimenter returned

<sup>1</sup>Participants in all five studies reported in this paper were undergraduate students at The University of Arizona who participated as partial fulfillment of course requirements. The sample sizes and gender breakdowns of the studies were as follows: McGregor et al. [1998] study 1, 38 males and 36 females; study 2, 27 males and 31 females; study 3, 17 males and 25 females; study 4, 16 males and 44 females; Lieberman and Greenberg [1998], 59 males and 89 females.

<sup>2</sup>Verbatim instructions are available from the authors on request.

and told them that they would be exchanging essays and reading a paragraph written by a fellow participant and giving their impression of it. Participants were then presented with an essay (actually written by the experimenters) that was designed to conflict with an importantly held belief. For example, in some studies [McGregor et al., 1998 (studies 1 and 2)], self-described liberal participants read an essay that criticized liberals (worldview threat condition) or one that criticized conservatives (worldview consistent condition). In these studies, we had previously obtained information about participants' political stance in a mass testing session. In another study [McGregor et al., 1998 (study 3)] where this information was not available to us, participants read an essay that disparaged the United States. Previous research [e.g., Greenberg et al., 1994] has demonstrated that this manipulation successfully provokes worldview defensive reactions in mortality salient (MS) participants. Accordingly, we predicted that exposure to the worldview-threatening essay should provoke increased aggression in MS participants.

Participants were then informed that in a "second study" we were examining the relationship between personality and taste preferences and that they would be tasting and giving their impression of a food sample. In the Lieberman and Greenberg [1998] juice sample variation, we simplified the procedure by eliminating the "first study" and only giving participants the cover story associated with this "second study." However, to maintain the cover story, participants were asked to initially complete several personality questionnaires (actually filler items used to enhance the credibility of the cover story).

For the second study, which was described as a "personality and taste preference study," the experimenter explained that different types of foods were being examined in different experiments and that dry (for the worldview threat variation—in the noxious juice variation we substituted the word "tart" for "dry") and spicy foods were being examined that day. Because a plausible explanation was needed as to why they, rather than the experimenter, were allocating the food samples, participants were told that the experimenter needed to be blind to certain specifics about the sample type and quantity of food tasted so it was necessary for participants to select the food samples for each other.

The experimenter then explained that although we were examining dry (tart) and spicy foods that day, we were also interested in other flavors and textures. Consequently, participants completed a "Taste Preference Inventory" that consisted of several 21-point rating scales (1 = no liking at all; 21 = extreme liking) to evaluate their preference for sweet, crisp, creamy, salty, spicy, and dry (tart) flavors. This questionnaire was included so that participants could later be presented with a bogus Taste Preference Inventory purportedly completed by the person to whom they were giving the hot sauce.<sup>3</sup>

Participants were given several minutes to complete the Taste Preference Inventory. The experimenter then entered the cubicle, collected the inventory from participants, and left again. The experimenter returned a few minutes later carrying a food sample. In the worldview threat variation, we had previously provoked participants with the

<sup>3</sup>Originally, in McGregor et al. [1998 (studies 1 and 2)] we used the flavor "sour" instead of "crisp" on the Taste Preference Inventory. However, in later studies where sour juice was used as a noxious stimulus we switched to crisp to avoid any potential problem of participants thinking the bad juice was actually a reward if they had indicated that they liked sour flavors. None of the participants commented on the fact that the type of sample they tasted (sour-flavored) was not on the Taste Preference Inventory.

essay, so at this point participants were given an envelope that contained a bland saltine cracker. The experimenter explained that the participant had been randomly assigned to the dry food group and that another participant had selected this food sample for them to taste. Participants were asked to consume it entirely and to evaluate their liking of it using a 9-point scale (1 = no liking at all; 9 = extreme liking).

In the noxious juice variation, the bland cracker was replaced with a juice sample to create an unpleasant experience [see, e.g., Harmon-Jones et al., 1996, for use of this method in past research]. To accommodate this procedural difference, several minutes after collecting the Taste Preference Inventory and leaving the cubicles the experimenter returned carrying a brown bag with their participant number written on it. Participants were told that the bag contained a bottle with a sample of juice in it that had been selected for them by another participant and that they “selected this flavor from a variety of flavors which ranged from neutral to very tart in taste. So, they could have given you any one of a number of flavors to taste, and this is the one they chose.” The taste of the juice was manipulated to be either very sour and distasteful or neutral and rather bland. The bad juice was a 2-oz (57g) mixture of unsweetened grape Kool-Aid with 1 teaspoon of white vinegar added. The vinegar had the effect of making it extremely unpleasant to drink. The neutral juice consisted of 2 oz (57g) of water with one drop of red food coloring and one drop of blue food coloring added to give the neutral sample an appearance identical to that of the bad juice. Participants were instructed to consume the entire amount of juice and then to rate the taste on a 9-point scale (1 = neutral; 9 = very tart) and their liking of the juice on a 9-point scale (1 = extreme disliking; 9 = extreme liking).

### **PANAS-X**

To assess affective reaction to the juice sample manipulation, immediately after participants drank and evaluated the juice they completed the positive and negative affect schedule (PANAS-X) [Watson and Clark, 1994]. The PANAS-X is composed of 60 items such as cheerful, disgusted, nervous, upset, angry, enthusiastic, guilty, and hostile. Participants were asked to “indicate to what extent you feel this way right now” to these items using a 5-point rating scale ranging from 1 (very slightly or not at all) to 5 (extremely). Presumably, participants in the bad juice groups should be upset that the target had selected such a distasteful flavor, which should be manifested in higher ratings on the hostility and negative mood subscales than the neutral juice groups. Thus, the PANAS-X serves as a useful manipulation check for the impact of this noxious stimulus.<sup>4</sup>

### **Hot Sauce Allocation**

After participants evaluated their food sample (and completed the PANAS-X in the juice sample variation) the experimenter returned to the cubicle and collected the materials. At this point in the TMT studies participants were told that they would be preparing a sample of hot sauce to give to another person and that, to avoid confusion, they

<sup>4</sup>In several of the TMT studies [McGregor et al., 1998 (studies 1–3)], participants completed the PANAS-X immediately after the mortality salience manipulation to assess the impact of this manipulation. Consequently, in these studies the PANAS-X does not provide a useful manipulation check for the worldview threat variable. Thus, PANAS-X data from these studies are not reported in this paper.

would be giving the hot sauce to the target whose essay they read (or who selected the juice for them).

Because the CEST study focused on displaced aggression, one of the main independent variables was target identity (i.e., the hot sauce was allocated to either the same person who provoked them or a different person). This variable was manipulated by presenting participants with written instructions informing them that the sample of hot sauce they allocated would be consumed by either the same person who selected the juice sample for them or another person. In the same written statement we also manipulated the independent variable of processing mode (PM) by telling participants to “carefully consider” the amount of hot sauce to allocate and to be as “rational and analytic as possible” (rational mode) or to go with their “natural, intuitive response” and to rely on their “gut-level reactions” in deciding the amount to give the target (experiential mode).

Next, in all the studies the experimenter then mentioned that because people are often curious as to the taste preferences of the other participants they would be shown the Taste Preference Inventory of the person to whom they would be giving the hot sauce. Participants were handed a bogus Taste Preference Inventory indicating that the target disliked spicy food. For the item “spicy—like hot salsa” the target indicated a liking of 3 on the 21-point scale (1 = no liking at all).

The experimenter left the cubicle and returned several minutes later carrying a tray with hot sauce, a 4-oz Styrofoam cup with a lid, a plastic teaspoon, a wooden taster spoon, and a cup of water. Participants were instructed to place a quantity of hot sauce into the Styrofoam cup using the plastic spoon and to seal it with the lid. The participants were told that all quantities of hot sauce were useful and to “put in as much or as little” hot sauce as they wanted. However, it was made clear to the participants that the person who received the hot sauce would have to consume the entire quantity of it. To be sure the participants were aware of the intensity of the hot sauce, they were instructed to taste a sample of it with the wooden spoon prior to allocating it to the target. A cup of water was also given to participants to eliminate any discomfort they may have experienced from tasting the hot sauce. In addition, by indicating that they would need something to wash the hot sauce down with, we were able to reinforce the notion that consuming hot sauce would be a noxious experience for the target.

Participants were then told that because the cups were covered, the experimenter would not know how much hot sauce had been allocated. To be sure that it was clear who would be receiving the hot sauce they prepared, they were reminded who they would be giving it to (e.g., the person whose essay they read) and were instructed to write that person’s participant number on the Styrofoam cup. Before leaving the cubicle, the experimenter handed the participants a checklist to remind them of each step involved in allocating the hot sauce. The experimenter then left and participants allocated the hot sauce to the target.

### **Hot Sauce**

Because the hot sauce was to be weighed, we wanted a substance that had an even consistency, that would ordinarily be applied in a volume greater than a drop or two, and that would be quite hot. Unfortunately, we could not find a commercial product that fulfilled all of these requirements. Consequently, we created our own hot sauce by combining several available commercial products in the following proportions: a mixture of 5 parts Heinz chili sauce and 3 parts Tapatio salsa picante hot sauce, produced

by the Empacadora Company (Vernon, CA). The final hot sauce had a consistency similar to cocktail sauce and was reported by participants during debriefings to be quite hot. Independent assessments of participants' reactions to the intensity of the hot sauce are reported later in this paper.

### Manipulation Checks

Finally, participants completed several manipulation checks. After being asked to indicate the type of food they had tasted, and the type of food they had given the target, they answered three other questions using 21-point rating scales: "To what extent did you use the Taste Preference Inventory when giving out the food sample to the other person?" (1 = not at all; 21 = completely); "How useful do you think the Taste Preference Inventory was when giving out the food sample?" (1 = not at all useful; 21 = extremely useful); and, "Using the scale below, indicate the extent to which the person you gave the food sample to liked that kind of food" (1 = no liking at all; 21 = extreme liking).

Additionally, participants in the Lieberman and Greenberg [1998] study completed Buss and Perry's [1992] Aggression Questionnaire (AQ), consisting of four subscales assessing trait aggressive tendencies: Physical Aggression, Verbal Aggression, Anger, and Hostility. Because hot sauce allocation is a behavioral measure of physical aggression, we expected to obtain a significant positive correlation between Physical Aggression scores and the amount of hot sauce allocated.

The experiment then concluded following a careful debriefing. Because some participants drank the unpleasant tasting juice, we made sure that they understood why that manipulation was used. Although participants reported that the juice tasted very unpleasant, no one reported being upset about our use of this manipulation. Additionally, special care was taken to ensure that the participants did not leave with any negative feeling that may have come from the knowledge that they may have caused someone pain and distress by assuring them that no one had tasted the hot sauce they had administered. We explained to them that they were simply responding to the situation that we put them in, and in no way should they feel as though they were aggressive or otherwise bad people for giving excessive amounts of hot sauce to the target. No participant indicated distress or objected in any way to the procedure, and many said that they were glad they had been involved in the experience.

## RESULTS

### Hot Sauce Intensity

Our first concern was whether participants would perceive the hot sauce as painfully spicy and whether actual pain and discomfort would come to a person who consumed an average quantity of it. To determine this we asked a separate sample of 10 participants to taste and rate the hot sauce. The hot sauce was rated quite hot ( $M = 7.2$  on a 9-point scale with endpoints of 1 [not at all hot] and 9 [extremely hot]). In addition, we asked the same sample to view a cup with 26.3g of the hot sauce (the mean amount allocated in the condition that produced the greatest amount of aggression in McGregor et al. [1998 (study 1)]) and to indicate how much pain or discomfort would be caused by consuming that amount of hot sauce. The participants indicated that considerable pain would be caused by consuming that amount ( $M = 7.8$  on a 9-point scale with endpoints of 1 [not much discomfort] and 9 [extreme discomfort]).

### Target's Dislike of Hot Sauce

To assure that participants had attended to the Taste Preference Inventory information regarding the target's dislike of hot sauce, we assessed the extent to which participants recalled and used that information. The target ostensibly rated hot sauce as a 3 on a 21-point scale. McGregor et al. [1998 (study 1)] reported that the mean response for recall of the target's rating of liking hot sauce, which did not differ by condition ( $F_s < 2.82$ ), was 3.70. Mean responses for the questions assessing the usefulness of the Taste Preference Inventory and the extent to which they used it, which did not differ by condition ( $F_s < 1.0$ ), were 17.3 and 16.2. Thus, participants in all conditions were equally aware that the target did not like spicy food and used this rating in deciding how much hot sauce to allocate. Results of four other studies [Lieberman and Greenberg, 1998; McGregor et al., 1998 (studies 2–4)] have replicated these findings.

### Hot Sauce Allocation

The main dependent measure of aggression was the weight in grams of hot sauce allocated to the targets, determined by weighing the hot sauce in the Styrofoam cups on an Ohaus Cent-O-Gram triple beam balance. Presumably, greater amounts of hot sauce should be administered in conditions that should theoretically produce greater amounts of aggression.

**TMT results.** Based on the theoretical assumptions of TMT, we predicted that participants would act aggressively and administer greater amounts of hot sauce when their mortality was made salient to them and they were confronted by a worldview-threatening target than they would when mortality was not salient to them or they were confronted with a target who did not threaten their worldview. In McGregor et al. [1998 (study 1)] a 2 (MS vs. control)  $\times$  2 (worldview threaten vs. worldview consistent) design was used to test this hypothesis. An analysis of variance (ANOVA) revealed a marginally significant main effect of target,  $F(1, 60) = 3.13, P < .09$ , reflecting the general tendency for participants to allocate more hot sauce to the worldview-threatening target than the worldview-consistent target. This effect was qualified, however, by the expected MS  $\times$  target interaction,  $F(1, 60) = 6.06, P < .02$  (means are displayed in Table I); our main hypothesis (that MS participants would allocate significantly more hot sauce to the author of the worldview-threatening essay than participants in the other three conditions) was supported by a planned orthogonal contrast:  $t(60) = 2.90, P < .01$ .

This basic finding was then replicated and extended in a second study [McGregor et al., 1998 (study 2)]. Previous TMT studies [e.g., Greenberg et al., 1990] have shown that worldview defense occurs when participants are given an opportunity to derogate the worldview threateners. Consequently, we were concerned in study 1 that if participants were given an opportunity to do this prior to allocating hot sauce, the need to aggress would be alleviated. We therefore had participants evaluate targets in a

**TABLE I. McGregor et al. [1998] Study 1—Cell Means for the Two-Way Interaction of Mortality Salience  $\times$  Target on Weight (in Grams) of Hot Sauce Allocated\***

	Mortality salient	Exam control
Worldview-threatening target	26.31 (21.87)	15.20 (8.39)
Worldview-consistent target	11.86 (8.33)	17.56 (11.34)

\*Standard deviations presented in parentheses.

nonjudgmental way prior to allocating the hot sauce. However, in study 2 we specifically investigated the possibility that hot sauce allocation for worldview-threatening targets following mortality salience would be attenuated or eliminated if participants were first given an opportunity to derogate them and, conversely, that if participants allocated hot sauce prior to evaluating the targets, their need to derogate them would be alleviated. Thus, participants were randomly assigned to one of three groups. The first group consisted of MS participants who allocated the hot sauce prior to evaluating the target. The second group allocated the hot sauce after evaluating the target. The third group served as a control group. These participants were asked to think about an anxiety-provoking situation other than death. We asked them to answer two questions about dental pain. The dental pain control participants allocated hot sauce first and then evaluated the target. Because there was no reason to expect high levels of aggression or derogation in the control condition, order of dependent variables was not manipulated in this condition.

We predicted that the MS-allocate-first (evaluate last) group would have a high need to aggress and would subsequently allocate more hot sauce than participants in the other two groups. An ANOVA on the weight (in grams) of hot sauce allocated to the target yielded a significant main effect for condition,  $F(2, 48) = 3.36, P < .05$  (MS-evaluate-last:  $M = 16.98$ ; MS-evaluate-first:  $M = 11.50$ ; Dental Pain control:  $M = 8.44$ ). A planned orthogonal contrast to test the hypothesis that MS-evaluate-last participants would allocate significantly more hot sauce to targets than participants in the other two conditions was significant,  $t(48) = 2.42, P < .02$ . A second contrast comparing MS-evaluate-first participants to dental pain participants was not significant,  $t(48) = .91, P > .36$ . Thus, MS participants allocated significantly more hot sauce when they were not able to verbally derogate the targets prior to the administration of hot sauce. However, when MS participants were able to first express their attitudes toward the target, the amount of hot sauce allocated was not significantly greater than for controls.

We interpreted these results as strong support for both our hypotheses and our measure of aggression. However, a pairwise (two-tailed) comparison of hot sauce allocation between the MS-evaluate-first and MS-evaluate-last conditions was only marginally significant ( $P = .11$ ). Consequently, a third study [McGregor et al., 1998 (study 3)] was undertaken in which all of the main results of study 2 were replicated and the pairwise comparison of hot sauce allocation between MS-evaluate-last participants and MS-evaluate-first participants was significant,  $t(39) = 2.14, P < .04$ . Additionally, when the data from studies 2 and 3 are combined, all ANOVAs are significant, as are all predicted differences, whether assessed by planned contrasts or pairwise comparisons, all  $P_s < .05$ .

One unanswered question that emerged from our research was whether the effects of MS on aggression were limited to worldview-threatening targets or whether they would also occur toward any target who aroused negative reactions in participants. TMT would predict that increased aggression would occur in the former case but not the latter because the latter target did not threaten the worldview. This issue was addressed in a fourth study [McGregor et al., 1998 (study 4)].

To provoke participants in a manner that did not threaten their worldview, we used the Juice Sample paradigm. As a result, we had MS participants and other participants allocate hot sauce to a target who had selected either a neutral or very unpleasant tasting juice for them to drink. We predicted that there would only be a main effect for sample type and no other main effects or interactions.

**Juice sample manipulation check.** Because juice was used as an aversive stimulus to provoke participants in a number of our studies, it was essential that participants in the bad juice condition have a negative reaction to its flavor. A number of measures indicated that this was the case. First, in Lieberman and Greenberg [1998], participants in the bad juice condition reported that their sample was significantly more tart (bad juice:  $M = 7.61$ ; neutral juice:  $M = 1.53$ ),  $t(137) = 23.46$ ,  $P < .01$ , and reported significantly less liking for the sample (bad juice:  $M = 2.66$ ; neutral juice:  $M = 3.87$ ),  $t(135) = 3.77$ ,  $P < .01$ , than neutral juice participants.<sup>5</sup>

Second, recall that the PANAS-X was administered immediately after participants consumed the juice sample. Because the juice was designed to be a noxious stimulus, participants in the bad juice condition should report greater feelings of negative affect and also greater feelings of hostility than participants in the neutral juice condition. A  $t$ -test revealed significant results on these measures. In McGregor et al. [1998 (study 4)], participants in the bad juice condition reported greater hostility (bad juice:  $M = 1.8$ ; neutral juice:  $M = 1.2$ ) and overall negative mood (bad juice:  $M = 1.48$ ; neutral juice:  $M = 1.18$ ),  $P_s < .03$ . A similar significant pattern of results was obtained on these two subscales in the study by Lieberman and Greenberg [1998] where participants in the bad juice condition also reported greater hostility (bad juice:  $M = 1.71$ ; neutral juice:  $M = 1.31$ ),  $t(134)$ , and overall negative mood (bad juice:  $M = 1.45$ ; neutral juice:  $M = 1.27$ ),  $P_s < .02$ .

Given that it has been repeatedly shown that participants are more likely to aggress against others who deliver a noxious stimulus to them [see, e.g., Baron and Richardson, 1994; Geen, 1990], further evidence for the effectiveness of hot sauce allocation as a measure of aggression could be determined.

**MS-juice stimulus results.** As expected, an ANOVA on the weight (in grams) of hot sauce allocated to the target yielded a significant main effect for sample type,  $F(1, 56) = 4.33$ ,  $P < .05$ . Bad juice participants allocated more hot sauce than neutral juice participants,  $M_s = 24.67$  and  $15.36$ , respectively. However, as predicted, there were no hints of a main effect of MS or an interaction of MS and sample type,  $F(1, 56) = .01$ ,  $P > .97$ , and  $F(1, 56) = .64$ ,  $P > .42$ , respectively. Means are displayed in Table II.

**CEST results.** The final study to date in which the hot sauce paradigm has been used focused on investigating the conditions that foster displaced aggression through the application of CEST. Lieberman and Greenberg [1998] predicted that displaced aggression would occur when participants were in an experiential mode because they would not focus on who the target of their aggression was. However, when participants were motivated to think in a rational mode they were expected to exhibit high levels of aggression only when the aggression could be directed at a target that had previously

<sup>5</sup>McGregor et al. [1998 (study 4)] also included similar manipulation checks for juice sample. In that study, participants who consumed the bad juice rated it significantly more tart (7.8) than did participants in the neutral juice condition (2.0),  $F(1, 56) = 130.32$ ,  $P < .01$ . However, on the measure of participant's liking of the juice sample, the difference was not significant,  $F(1, 56) = 1.07$ ,  $P > .43$ . Bad juice participants reported only slightly less liking for the juice (1.7) than neutral juice participants (2.0). This unexpected result is likely due to a shortcoming of the rating scale used to assess liking for the juice sample. In McGregor et al. [1998 (study 4)], the scale ranged from 1 (no liking at all) to 9 (extreme liking). The endpoint *no liking at all* does not permit participants to express any extreme disliking that they may have had for the sample. Rather, it reflects a neutral level of liking. When this endpoint was replaced with *extreme disliking* in the study by Lieberman and Greenberg [1998], the expected significant differences emerged.

**TABLE II. McGregor et al. [1998] Study 4—Cell Means for the Two-Way Interaction of Mortality Salience  $\times$  Sample on Weight (in Grams) of Hot Sauce Allocated\***

	Mortality salient	Dental pain control
Bad juice	22.82 (14.26)	26.53 (25.78)
Neutral juice	17.07 (9.39)	13.64 (15.74)

\*Standard deviations presented in parentheses.

provoked them. As described above, participants were motivated to think either rationally or experientially, given either a sample of bad or neutral juice, and were informed that the hot sauce would be given to either the same person who chose the juice sample for them or a different person. We expected that participants in the neutral juice conditions would not have a need to aggress because they had not been provoked; consequently, target and PM should have no effect. However, individuals given the bad juice sample should show high levels of aggression toward both the provocateur and other targets in the experiential condition but only toward the provocateur in the rational condition. Thus, we predicted a main effect for juice sample and a three-way sample  $\times$  target  $\times$  PM interaction.

The ANOVA on the weight in grams of hot sauce allocated to targets yielded a significant main effect of sample,  $F(1, 123) = 16.01, P < .001$ . As expected, participants who consumed the bad juice allocated significantly more hot sauce ( $M = 23.10$ ) than did those who drank the neutral juice ( $M = 14.45$ ). There was also a significant three-way sample  $\times$  target  $\times$  PM interaction,  $F(1, 123) = 5.51, P < .03$ . Means are presented in Table III. A planned contrast comparing hot sauce allocations in the bad juice-rational mode-different target condition to the other three bad juice conditions was significant,  $t(60) = 2.90, P < .01$ . Thus, the main hypothesis, that when participants were provoked they would take information about the target into account only when they were in a rational mode was supported.<sup>6</sup>

### AQ Measure

Further validation for our measure of hot sauce allocation came from correlations between hot sauce allocation and the AQ self-report aggression measure. The AQ mea-

**TABLE III. Lieberman and Greenberg [1998]—Cell Means for the Three-Way Interaction of Sample Target  $\times$  Processing Mode on Weight (in Grams) of Hot Sauce Allocated\***

	Rational	Experiential
Neutral juice		
Provocateur	11.56 (5.03)	18.25 (25.01)
Other	14.05 (7.07)	13.99 (9.81)
Bad juice		
Provocateur	24.43 (14.98)	23.93 (19.57)
Other	15.44 (7.08)	29.05 (14.26)

\*Standard deviations presented in parentheses.

<sup>6</sup>The unexpectedly high mean of 18.25g of hot sauce allocated in the neutral juice-same target-experiential mode condition was principally a product of one outlying participant who allocated 102.25g in this condition. When this participant's data are removed from the sample, the mean allocation for that condition drops to 13.00g.

sure has four subscales: Physical Aggression, Verbal Aggression, Anger, and Hostility. Because hot sauce allocation is a measure of physical aggression, we expected a significant positive correlation between the amount of hot sauce allocated and Physical Aggression scores. Indeed, these measures were significantly correlated for participants in the rational mode,  $r(57) = .35$ ,  $P < .01$ . However, this correlation was not significant when participants were in an experiential mode,  $r(58) = .03$ , ns. The correlation between self-reported Hostility and hot sauce allocation was also marginally significant for rational mode participants,  $r(57) = .23$ ,  $P = .082$ , but not for experiential mode participants,  $r(57) = -.19$ , ns. None of the other correlations were significant for the subscale measures ( $P$ 's  $> .18$ ). In addition, when the data from the AQ subscales were combined into one overall aggression scale there was a significant positive correlation between self-reported aggression and hot sauce allocation for rational mode participants,  $r(55) = .30$ ,  $P < .03$ , but not for experiential mode participants,  $r(57) = .01$ , ns. This evidence provides some concurrent validity of hot sauce as a measure of aggression. The lack of a significant relationship between self-reported aggression scores and behavior in the experiential (emotional) mode may indicate that when individuals are processing information in an emotional state, they may be highly subject to the demands that the current situation places on them and may not be controlled by their dispositions and attitudes. However, when individuals are in a rational state, dispositional factors are more likely to operate. Of course, more work is need to assess the validity of this interpretation.

## DISCUSSION

The purpose of this paper was to describe the use of hot sauce allocation as a new method of measuring physical aggression. The hot sauce paradigm has been used in five studies to date, and results supporting the validity of this measure have been obtained utilizing two different theoretical perspectives—TMT and CEST. Participants in these studies were provoked using both two different worldview-threatening essays (a manipulation that in previous TMT research has led to derogation of targets) and a noxious stimulus of aversive tasting juice and responded in the expected manner after provocation by allocating significantly more hot sauce in the conditions that theoretically should have produced the greatest amount of aggression.

Additional convergent validity for this new measure has been obtained by moderate correlations between hot sauce allocations and the Buss and Perry [1992] Aggression Questionnaire, although these correlations appear to be largely dependent on whether participants are in rational or experiential mode when allocating hot sauce. The limited correlations between self-reported trait aggression and hot sauce allocation are not all that surprising given the general track record of personality trait measures as predictors of specific instances of behavior, especially under conditions in which experimental treatments are highly impactful [see, e.g., Ross and Nisbett, 1991].

To date we have had only two minor complications with the use of this measure. First, a few participants (<2%) have refused to consume a sample of the hot sauce because of reported food allergies (these participants were dropped from the study). Second, we have had heterogeneity of variance between different cells in our experimental designs, with the largest variance occurring in the cells where the greatest amount of hot sauce was allocated. This was mainly because a few participants allocated a very

large quantity of hot sauce in the conditions that should theoretically produce the greatest aggression (e.g., the MS-worldview threat condition). In fact, a number of participants in this condition completely filled the Styrofoam cup with hot sauce. Thus, the heterogeneity is a reflection of extremely high amounts of aggression being demonstrated by these participants. Heterogeneity of variance is a threat to the assumptions of ANOVA when cell sizes are unequal. But this problem can be easily overcome through the use of equal cell sizes; or an alternative approach is to use one of several data transformations such as square root, log, or reciprocal transformations [Kirk, 1995] to restore homogeneity of variance.

The results of these studies provide support for the notion that hot sauce allocation is a valid laboratory measure of aggression that is not subject to some of the theoretical, ethical, and/or practical limitations of other existing measures. A fundamental aspect of the definition of aggression is an intent to harm the individual who is the object of aggression [Baron and Richardson, 1994; Berkowitz, 1993; Geen, 1990]. Thus, an appropriate measure should convey to participants that actual harm could come from their actions. It was clear to participants that consuming a large quantity of hot sauce would inflict physical discomfort to the target. That target was another person in the same study rather than an inanimate object. The aggressive behavior was not sanctioned or encouraged by the experimenter, who simply instructed participants to administer “as much or as little” hot sauce as they wanted. Although participants were able to allocate a quantity of hot sauce that would inflict considerable physical pain to a target if they so desired, no target actually consumed the hot sauce. Thus, there is no potential for actual physical harm to occur during the study. Finally, during the debriefing, many participants indicated that they thought the hot sauce was quite hot and reported allocating large amounts of hot sauce because they did not like the target. Thus, many participants were aware that their behavior was aggressive in nature. Participants also reported being surprised to learn that the target did not actually consume it. The fact that they actually consumed a food sample earlier in the experiment, and knew other participants were in the same experimental session with them, probably contributed to the high level of believability.

As noted earlier, an additional benefit of the hot sauce measure is that although it shares the limitation with virtually all laboratory measures of aggression in that it is not similar to the most common and egregious forms of real world aggression, there have been numerous recorded cases of individuals using hot sauce to inflict pain on others. Thus, the hot sauce paradigm provides participants with an opportunity to clearly (but safely) aggress against a target whom they believe is real using a behavior that they could perform outside the laboratory. Given these advantages, we are hopeful that this methodology will prove beneficial to other researchers investigating human aggression.

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