Examining an Affective Aggression Framework: Weapon and Temperature Effects on Aggressive Thoughts, Affect, and Attitudes

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A general framework for studying affective aggression, integrating many insights from previous models (e.g., those of Baron, Berkowitz, Geen, and Zillmann), is presented. New research examining effects of extreme temperatures and photos of guns on arousal, cognition, and affect is reported. Hostile cognition was assessed using an automatic priming task (i.e., Stroop interference). Hostile affect was assessed with the State Hostility Scale. Positive and negative affect, hostile attitudes, perceived comfort, and perceived arousal were also assessed. As expected, hot and cold temperatures increased state hostility and hostile attitudes, and viewing guns did not. As expected, viewing guns primed hostile cognitions and extreme temperatures did not. Theoretical implications of these results and societal implications of the general framework are discussed.

The United States experienced 23,760 murders, 109,062 forcible rapes, and 1,126,974 aggravated assaults in 1992 (U.S. Department of Justice, 1993). That breaks down to a murder every 22 min, a rape every 5 min, and an assault every 28 s. Of murders for which the precipitating event was known, 50% more resulted from an argument than from the commission of a felony (e.g., robbery, narcotics offenses, sex offenses). In other words, many violent behaviors occur when people who know (and often love) each other get into serious arguments. They get angry and lash out. Sometimes they "merely" assault; at other times they kill. This type of aggression, characterized by anger and intent to harm, is known as affective aggression (e.g., Geen, 1990), though sometimes it is called impulsive or emotional aggression.

Our current research on affective aggression draws heavily on insights from Berkowitz's (1984, 1990, 1993) cognitive neoassociation model (CNA), Geen's (1990) affective aggression model, and Zillmann's (1983) excitation transfer model. In addition, Baron's (1979) negative affect escape model has contributed (see also Anderson, 1989; Anderson & DeNeve, 1992). Our framework (see Figure 1) deals with the current state of the individual. It does not cover the development of individual differences in aggressive inclinations and skills (e.g., Bandura, 1973; Dodge & Crick, 1990; Huesmann, Eron, Lefkowitz, & Walder, 1984). We focus on the processes by which various basic inputs can be transformed through a series of stages to an increase in the anger/hostility experience and eventually to aggressive behavior. Most aggression research has focused on the first and last stages in the this framework, linking the basic inputs to aggressive behavior, with relatively little empirical work on the intermediate stages. For instance, researchers have shown that trait input variables such as trait hostility and attitudes toward violence as well as situational input variables such as photos of guns, hot

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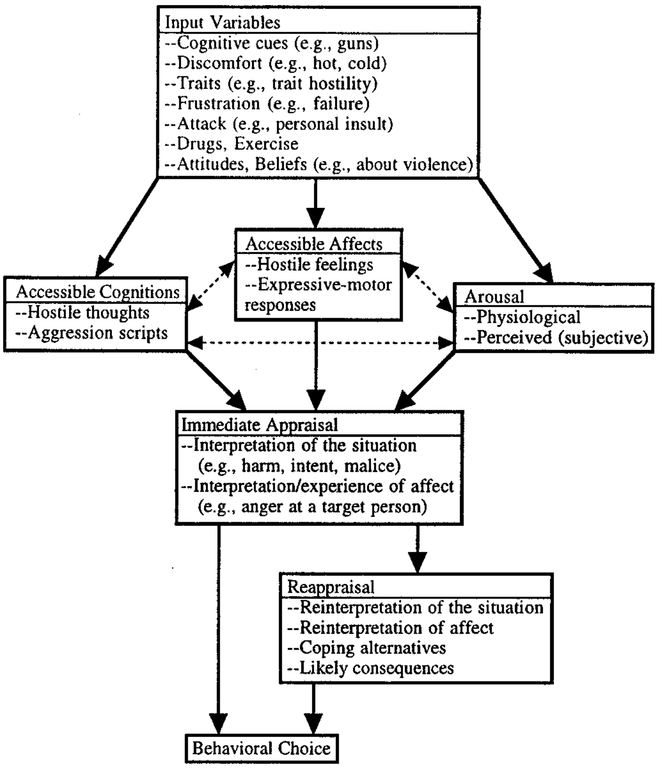

Figure 1 A general framework of affective aggression.

temperatures, personal insults, and strenuous exercise can produce increases in aggressive behavior (Berkowitz, 1993; Green, 1990). But how do these disparate input variables produce these effects? The framework outlines a general answer to this question.

AFFECTIVE AGGRESSION: A GENERAL FRAMEWORK

Input Variables and Three Routes

We propose that variables known to influence affective aggression operate through at least one of three routes—cognitive, affective, or state of arousal. Like Berkowitz (1990, 1993) and many others, we believe that knowledge structures include thoughts, feelings, memories, behavioral scripts, and expressive-motor programs. Central to this perspective is the spreading activation assumption. Activation of one element in a network tends to automatically increase the accessibility of other elements in that network. The degree of activation of other elements varies as a function of the strength of the linkages between elements and the strength of the initial activation.

Our framework differs from Berkowitz's CNA model in three important respects. First, ours highlights three different initial routes of influence; CNA emphasizes a general negative affect route and the cognitive, expressive-motor, and arousal reactions that can result (by means of spreading activation) from negative affect. Second, we view immediate appraisal as automatic, thus locating some results usually thought of as occurring without appraisal (e.g., impulsive aggression) after this automatic appraisal stage (e.g., Berkowitz, 1993; Frijda, Kuipers, & ter Schure, 1989). Third, our framework does not link the affective, cognitive, and arousal aspects quite so completely as in current formulations of CNA. We agree that these aspects of the anger-hostility-arousal syndrome cannot be understood independently; we also believe that these aspects differ sufficiently to warrant separate, but interconnected, routes (see Forgas, 1992; Izard, 1993; Zajonc, 1980). Thus we link three separate routes, illustrated by the dashed lines in Figure 1.

Many input variables traverse two or all three routes. Furthermore, the priming effects of spreading activation can operate so quickly and strongly that distinguishing between a direct priming effect of an input variable and an indirect effect sometimes becomes impossible. Still, we maintain separate routes because we believe that some input variables do clearly traverse one particular route.

How the Routes Operate

In the cognitive route, input variables increase the accessibility of hostility-related thoughts, schemata, and behavioral scripts as guides to the interpretation of incoming information. For example, a person viewing guns is more likely to gain access to hostile thoughts than a person viewing nature scenes. At first glance, this route may seem to be a purely cognitive one and thus irrelevant to an "affective aggression" model. However, we believe that variables traversing this route produce increases in anger when the incoming information has anger-eliciting properties that can be interpreted in a biased fashion.

In the affective route, input variables create hostile mood states. Temperature effects on aggression presumably operate this way. Input variables such as trait hostility and personal insults may similarly instill negative affect in people.

In the arousal route, input variables work by an excitation transfer or misattribution of arousal process (Zillmann, 1983, 1988). Pain, certain drugs, and exercise, for instance, tend to increase arousal. Unexplained arousal may instigate a search of the environment for cues about its cause. If a salient hostility-relevant cue is present, such as an insult, the unexplained arousal is transferred (or misattributed) to it, resulting in heightened anger.

Subsequent Stages

Immediate appraisal is spontaneous, automatic, and very fast. The person interprets the current situation and his or her affective state quickly, with particular reference to harm, intent, and malice, as well as feelings of anger. Immediate arousal is in essence the product of the person's initial attempt to understand the events under observation (see Dodge & Tomlin, 1987, for work on self-schemata and interpretation bias). This stage is quite similar to the characterization stage postulated in recent models of the attribution process (e.g., Anderson, Krull, & Weiner, in press; Gilbert, Pelham, & Krull, 1988). In a crowded bar, for instance, people sometimes jostle and bump one another. The immediate appraisal of such encounters very much depends on the state of mind (i.e., accessible cognitions, affects) and state of arousal of the appraiser. This immediate appraisal includes both cognition and emotion, each of which can feed directly into the process of choosing to aggress or to engage in some other behavior. For instance, the emotional experience itself may include specific action readiness modes (e.g., Frijda et al., 1989).

Alternatively, reappraisal may occur, depending on at least two factors—importance and availability of resources. If the event is important and there are sufficient resources (time, cognitive capacity), then the person will perform a more thorough appraisal before choosing a behavioral option. Reappraisal, like the correction stage of Gilbert et al. (1988) and the problem-based explanation stage of Anderson et al. (in press), is more thoughtful, effortful, and conscious. Additional information is brought to bear, sometimes producing a very different attribution. Other aspects of reappraisal include consideration of (a) alternative behavioral responses, (b) ability to carry out various alternatives (efficacy expectations), and (c) the likely consequences of alternatives (outcome expectations). (For discussions of such processes, see Berkowitz, 1993; Geen, 1990; and Baron & Richardson, 1994.)

Additional Notes on the General Framework

In addition to delineating what the framework does say, we emphasize what it does not. First, it does not restrict the effects of any given input variable to one and only one route. Hot temperatures, for instance, may increase aggression by both the negative affect and the arousal routes. Second, the framework does not say that input variables operate independently of one another. We expect some interactions depending on the input variables, the situational context, and the dependent variable. For instance, watching violent movies may well influence the accessibility of aggressive thoughts primarily for certain types of people (e.g., Bushman, 1995). Third, the framework does not specify the route(s) used by any specific input variable. Domain-specific theories are necessary to generate predictions for a particular independent variable.

In this article, we focus on two input variables (uncomfortable temperatures and viewing of weapons) and on two routes (cognitive and affective). The framework is explicitly mediational in that various cognitive, affective, and arousal states mediate the relations between input variables and behavior, but the present research focuses only on the early stages. We do this because so little is known about them. In future research, we plan to examine later stages and to test more directly the mediational features of the model.

TEMPERATURE AND AGGRESSION

Aggressive Behavior

A recent review (Anderson, 1989) found that field and archival studies consistently demonstrate increases in aggression at hot temperatures. Murder, rape, assault, spouse abuse, and family disturbances all tend to occur most frequently under hot conditions. In contrast, laboratory studies have yielded mixed results, perhaps because of subject reactivity problems (see Rule & Nesdale, 1976). Further advances in understanding temperature effects require work on the cognitive, affective, and arousal routes in our model.

Affect

Several studies have examined effects of hot temperatures on comfort, usually as manipulation checks. Not surprisingly, subjects in hot rooms rate the rooms (or themselves) as hotter, more unpleasant, and more uncomfortable than subjects in normal-temperature rooms (Baron & Bell, 1975, 1976; Bell & Baron, 1974; Bell, Garnand, & Heath, 1984; Griffitt, 1970; Griffitt & Veitch, 1971). Cold temperatures were not used in these studies. Griffitt and Veitch (1971) and Anderson, Deuser, and DeNeve (1995) used self-report affect scales and provide the only evidence to date that heat increases aggressive affect.

Overall, effects of uncomfortable temperatures on aggressive affects are unknown and largely untested. The present experiment investigates both hot and cold temperature effects on negative affect at both a specific level (state hostility) and a general level.

Cognitive State

Two studies have examined the effects of hot temperatures on a cognitive state variable. Rule, Taylor, and Dobbs (1987) had subjects read and complete story stems under normal or hot conditions. Some of the story stems were aggression relevant; others were not. Heat increased aggressive completions for aggression-relevant story stems but not for neutral story stems. Anderson et al. (in press) showed an increase in agreement with hostile belief and attitude statements at hot temperatures. Though suggestive, both sets of results provide little support for a *direct* hot temperature/aggressive cognition link; they may instead reflect priming of affective components. Cognitive association models suggest that discomfort can automatically and directly prime hostile cognitions. Testing this specific prediction requires use of an interference or facilitation paradigm from the semantic priming literature, such as the Stroop interference paradigm.

Arousal

Various literatures suggest that hot temperatures increase heart rate, decrease self-reported arousal, and increase activity level (see Anderson, 1989, for a brief review). We have found that brief exposure (about 15-25 min) to hot temperatures increases heart rate whereas cold temperatures produce a decrease; subjective perceptions of arousal show exactly the opposite relation (Anderson et al., in press; Deuser, DeNeve, Anderson, Wood, & Anderson, 1991). Because Cantor, Zillmann, and Bryant (1975) showed that the optimal situation for excitation transfer is when physiological arousal is increased while the person is subjectively unaroused, these temperature effects suggest that hot temperatures may increase aggression via the arousal route as well.[1]

Specific Theory Predictions for Temperature

We believe that uncomfortable temperatures work mainly through the affect route. We specifically predicted that both hot and cold temperatures would increase anger/hostility feelings.[2] We also expected that affect measures of a more general nature would be related to temperature but that the effect would be weaker, because we do not expect uncomfortable temperatures to influence negative affects such as guilt, fear, or shame.

Rule et al. (1987) and Anderson et al. (1995) suggest that hot temperatures may operate via a cognitive route as well, but those works did not test whether uncomfortable temperatures could directly prime aggressive thoughts in an automatic fashion. Consequently, we had no firm expectation about temperature effects on priming of hostile cognitions.

GUNS AND AGGRESSION: THE WEAPONS EFFECT

Berkowitz and LePage (1967) first demonstrated that provoked subjects behaved more aggressively when a weapon was in sight. Although the weapons effect does not always occur, it has replicated many times with different settings, age groups, and research teams (reviewed in Turner, Simons, Berkowitz, & Frodi, 1977). The phenomenon has also been demonstrated when photos of weapons were used (Leyens & Parke, 1975). The original explanation was that guns serve as classically conditioned stimuli to aggression responses.

In more recent terms, the concept of gun is linked in memory to some elements of hostility-related cognitive schemata. Accordingly, we expected that exposure to photos of guns would increase the accessibility of hostile cognitions. Conversely, there is no theoretical reason to link the weapons effect directly to the affective or arousal route. We therefore expected that gun photos would not influence feelings of hostility or perceptions of arousal.

OVERVIEW OF THE STUDY

The main purpose of this research was to examine the effects of two input variables—temperature and viewing of weapon photos—on the cognitive and affective routes. We also assessed perceived arousal, both to replicate previous findings on temperature effects and to confirm that viewing weapons has little impact on such subjective perceptions. For half the subjects, we measured the accessibility of hostile cognitions with a modified Stroop color-naming task (Stroop, 1935). The other half performed two simpler (and shorter) reaction time tasks designed to assess cognitive accessibility. As explained later, these two simpler tasks proved unreliable and so were not analyzed.

We measured affect in three ways. One measure focused on current hostile state; the other two were general measures of current positive and negative affect. We also assessed hostile attitudes. This measure could be seen a priori as either a cognitive or an affective measure. Other internal analyses presented later demonstrate that in the present context it is best understood as a fourth measure of affective state.

METHOD

Design

The experimental design was a mixed factorial. A 3-level within-subjects factor was the type of word presented in the cognitive tasks. Of primary interest were aggression-related words (e.g., *assault, hurt, choke*) and control words (e.g., *absorb, chant, relax*). The third type was escape words (e.g., *escape, exit, move*), which allowed us to examine the possibility that uncomfortable temperatures and gun photos prime escape schemata as well as hostile ones (see Baron, 1979). The two main between-subjects factors were the type of prime that the subject viewed in the beginning of the experiment (guns or nature scenes) and temperature (assigned in five conditions from 55 to 95° F). As noted earlier, an additional between-subjects factor was the type of cognitive performance task.

TABLE 1: Stimulus Words, With Length (*n*) and Familiarity (*f*) by Category

Aggressive Words	*Control Words*	*Escape Words*
Assault	Absorb	Abandon
Attack	Access	Avert
Butcher	Behold	Avoid
Choke	Bloom	Depart
Destroy	Button	Desert
Harm	Chant	Disappear
Hurt	Discover	Escape
Injure	Imagine	Evacuate
Murder	Improve	Evade
Punch	Listen	Exit
Shatter	Mellow	Flight
Shoot	Read	Forsake
Slaughter	Recruit	Leave
Smother	Relate	Move
Strike	Relax	Quit
Torment	Rent	Release
Torture	Revolve	Resign
Violate	Suggest	Retreat
Wound	Transfer	Vanish
Wreck	Watch	Withdraw
$M_n = 6.05$	$M_n = 6.10$	$M_n = 6.05$
$SD_n = 1.12$	$SD_n = 1.18$	$SD_n = 1.36$
$M_f = 40.6$	$M_f = 45.3$	$M_f = 41.5$
$SD_f = 28.5$	$SD_f = 34.0$	$SD_f = 29.6$

Subjects

Introductory psychology students at a large midwestern university participated for class credit. All spoke English as their primary language. All wore a short-sleeve shirt and long pants. Those assigned to the Stroop task were screened for colorblindness. In all, 199 males and 252 females completed the experiment. Data from 24 (5%) were discarded because at least a minimal level of suspicion was expressed in the debriefing. Keeping these data did not change the results in any appreciable way.

Temperature Lab Rooms

Subjects were randomly assigned to one of two identical temperature-controlled rooms. Each contained a 13-in. color monitor linked to a Macintosh IIcx computer in another room, a sound key (MacRecorder), and an intercom unit. One temperature room was randomly set at a target temperature; the other room was yoked. Specifically, the cold air outlet of a heat pump was ducted into the "cold" room; the hot air outlet was ducted into the "hot" room. In this way, if one room was randomly set to be 85°F, the other was yoked to be approximately 65°F. All sessions on a given day were randomly assigned to target temperatures of 55, 65, 75, 85, and 95 °F. Two subjects, staggered 15 min apart, were run in every session. The first subject was randomly assigned to one of the two lab rooms. A third room, designated the "start" room, was kept at a comfortable temperature (about 71°F). The consent form, preliminary instructions, photo prime task, hostile attitudes questionnaire, and debriefing were given in this room.

Photo Primes

Subjects were randomly assigned to view 18 magazine photographs of guns or of nature scenes. No advertising messages appeared on the photographs.

Words: Aggressive, Control, Escape

The stimuli for the cognitive performance tasks were words presented on the computer. Some words were selected from a thesaurus; others were obtained from previous studies (Geen & George, 1969; Geen & Stonner, 1971). Twenty aggression (e.g., *assault, hurt*), 20 control (*absorb, chant*), and 20 escape words (*escape, exit*) were chosen. The word categories were equated for length and were deemed above an acceptable level of familiarity using the Thorndike-Luge Inventory. Table 1 presents the word lists.

Cognitive Performance Tasks

Stroop interference task. Half the subjects performed this task. A computer presented the words in one of five colors (red, blue, green, yellow, or white) against a black background. The subject's task was to quickly name the color in which the word was printed. Words appeared one at a time on the screen shortly after the subject finished saying the previous word. Response times were recorded by the computer in milliseconds. Each word appeared in each of 5 blocks of 60 trials, for a total of 300 trials.

This task was used to determine whether subjects were primed to think aggressive thoughts by viewing gun photos or by experiencing uncomfortable temperatures. If so, they would take relatively longer to name the color of the aggressive words than the control words (relative to those in the nature photo or comfortable condition) because the automatic tendency to read a primed word interferes with naming its color (Dyer, 1973; Higgins, Van Hook, & Dorfman, 1988; Warren, 1977). In this type of cognitive task, the relevant control condition consists of reaction times (RTs) to control words. There are two reasons for this. First, individual differences in RT can be removed from the error term with this within-subjects procedure. Second, the theoretical prediction is that the prime stimulus influences reactions to the primed category more than it influences unrelated categories. Thus we explicitly predicted that the aggression-minus-control-word RTs would be greater for gun photo than for nature scene subjects. We had no prediction for the escape words. However, the same RT difference procedure was used to measure accessibility of escape schemata.

To assess the reliability of this task, average RTs to each type of word were calculated for each of the live blocks of trials. The internal reliability of these scores was then assessed using coefficient alpha. Alphas of .96, .95, and .96 were obtained for aggressive, escape, and control words, respectively.

Memory and perceptual facilitation tasks. The other half of the subjects performed both of these cognitive tasks. The memory facilitation task required subjects to remember sets of words flashed on the computer screen. This task proved quite unreliable, with alphas ranging from 0 to .23 for the three word types. The perceptual facilitation task varied the duration of time that word sets were flashed on the computer screen until the subject could read all the words. This task also proved unreliable, with alphas ranging from .46 to .55 across word types. Therefore, these dependent variables were not analyzed.

Affect Measures

State hostility. The State Hostility Scale (Anderson et al., 1995) presents 35 statements (e.g., "I feel furious") rated on 5-point scales anchored at *strongly disagree* (1), *disagree* (2), *neither agree nor disagree* (3), *agree* (4), and *strongly agree* (5). Twelve items represent a lack of hostility (e.g., "I feel polite"); these are reverse-scored. The adjectives in the statements are from the Multiple Affect Adjective Check List Hostility Scale (Zuckerman, Lubin, Vogel, & Valerius, 1964) and the Spielberger State Anger Scale (Spielberger, Jacobs, Russell, & Crane, 1983). In the present experiment, Cronbach's alpha was .95.

PANAS. PANAS consists of 10 positive and 10 negative affect adjectives (Watson, Clark, & Tellegen, 1988). Subjects rate "the extent you feel this way right now" on 5-point scales from 1, *very slightly or not at all*, to 5, *extremely*. The reliabilities for these two scales were somewhat low, .89 and .76 for positive and negative affect. However, they were deemed sufficiently high to warrant further analysis.

Perceived Comfort

The Perceived Comfort Scale (PCS) consists of 10 adjectives rated on a scale of 1, *very slightly or not at all*, to 5, *extremely*, to indicate "the extent you feel each word describes the room right now, that is, at the present moment." Adjectives were derived by brainstorming comfort-laden words and then looking for their synonyms/antonyms in a thesaurus. Six indicated comfort (*comfortable, cozy, pleasant, restful, snug, soothing*), whereas the remaining four indicated discomfort (*miserable, painful, stressful, uncomfortable*). The PCS was essentially a manipulation check, used to see whether sufficiently hot and cold temperatures were achieved. It was sufficiently reliable, with an alpha of .90.

Perceived Arousal

Perceived arousal was assessed by the 24-item Perceived Arousal Scale described in Anderson et al. (1995). Subjects rate 24 adjectives on "the extent you feel this way right now, that is, at the present moment" on a scale of 1, *very slightly or not at all*, to 5, *extremely*. Ten of the items indicate arousal (e.g., *energetic*), and 14 items indicate a lack of arousal (e.g., *sleepy*). This scale was included to replicate earlier findings that hot temperatures decrease perceived arousal whereas cold temperatures increase it. Cronbach's alpha was .93.

Hostile Attitudes

The Hostile Attitudes Scale (HAS) was created by combining the Caprara Irritability Scale (30 items; Caprara et al., 1985) and the Velicer Attitudes Toward Violence Scale (46 items; Velicer, Huckel, & Hansen, 1989). Subjects indicate their agreement with each item, using a 7-point rating scale anchored at 1, *disagree strongly*, and 7, *agree strongly*. The Caprara items focus on beliefs about how one has typically behaved in the past (e.g., "When I am irritated, I need to vent my feelings immediately"). The Velicer items focus on beliefs about various aggressive ways of behaving (e.g., "University police should beat students if they are obscene"). Ten of the items were reverse-scored because they reflect nonhostile attitudes (e.g., "I have never been touchy"). Cronbach's alpha was .93.

The HAS was included to see whether such attitudes could be at least temporarily changed by either uncomfortable temperatures or gun photos. But is it primarily a cognitive measure, with changes reflecting the priming of different types of thoughts? Or is it primarily an affective measure, with changes reflecting shifts in affective state? In a previous study (Anderson et al., 1995), we regarded a similar composite scale as a cognitive measure. Preliminary analyses of the present research indicated that it is best understood as an affective measure. Hostile attitudes correlated significantly with state hostility ($r = .21$, $n = 410$, $p < .001$) but did not correlate with the relative accessibility of hostile cognitions in the Stroop task ($r = .08$, $n = 196$, $p > .25$). Furthermore, the significant correlation with state hostility persisted even after the effects of temperature (linear and quadratic) were statistically controlled ($p < .001$).

Procedure

Cover story. Subjects were told the study concerned effects of environmental stressors such as temperature on cognitive performance. They were to complete a computer task and some questionnaires. While the subject read a consent form, the experimenter "checked" the temperature lab. The experimenter then explained that the lab was not at the right temperature yet and that it would be a few minutes before the experiment began.

Photo prime. Next, the subject was asked, "Would you be willing to help out one of my colleagues who is conducting a pilot study on use of colors in ads by looking at some ads and filling out an advertisement survey? Since this is for another study, you don't have to fill out the survey if you don't want to." Twelve persons chose not to do this "survey." They were not included in the main data analyses.

Subjects in the gun prime condition rated 18 photos of handguns and rifles. Nature scene subjects rated 18 photos of nature scenes. The photos were described as ads for weapons or national parks. Subjects rated how much they liked the colors in each ad, how much they liked each ad, and how often they had seen each ad.

Temperature manipulation. The subject was then taken to a lab room, seated in front of a computer screen, and given an overview of the experiment. Depending on the random assignment, the room temperature was adjusted to 55, 65, 75, 85, or 95 °F. Relative humidity and actual temperature were recorded at the conclusion of the session. We performed a variety of analyses with humidity as a factor. As in previous studies (e.g., Anderson et al., 1995; Deuser et al., 1991), humidity did not contribute a significant unique increment in explained variance in any dependent variable. Although humidity is an important factor in comfort levels, the range of humidity in our lab is so small that it becomes a redundant predictor. It was therefore dropped in all final analyses.

Cognitive performance tasks. Subjects were given written instructions for the cognitive tasks by computer. The cover story had also been presented in the consent form and by the experimenter on arrival. Before starting the computer program, the experimenter briefly explained the cognitive tasks. In the Stroop conditions, the experimenter observed the subject performing 10 practice trials. Subjects' oral responses to the Stroop task were recorded on audiotape.

Questionnaires in the temperature room. After completing the cognitive performance tasks, subjects were given several questionnaires to complete while still in the temperature lab. The first questionnaire assessed perceived comfort. Next, subjects completed a "Current Feelings and Emotions" questionnaire, which included the Perceived Arousal, Positive Affect, and Negative Affect scales. The third questionnaire, labeled "Current Mood," was our State Hostility Scale.

Back to the start room. The subject returned to the start room and was asked to fill out an "attitude survey"; this was our Hostile Attitudes Scale. Finally, each subject was fully debriefed orally and in writing. Care was taken to ensure that subjects were not offended by deceptions concerning the true goals of the research. Because suspicion has been proposed as a problem in earlier research on temperature and aggression, we conducted a detailed structured interview with each subject as part of the debriefing process.

RESULTS

Analysis Strategy

Two strategic decisions regarding analysis and presentation deserve attention. We decided (a) to treat temperature as a continuous variable and (b) to use a Bonferroni correction of alpha for tests not relevant to the model to protect against an excessive Type I error rate.

Temperature as a continuous variable. As in past research (e.g., Anderson et al., 1995), actual temperatures varied slightly from the five target temperatures. The actual temperature range was 55 to 98°F. Temperature was therefore converted to deviation score form and used as a continuous variable. The average temperature across all conditions was 74.9°F. For the Stroop task conditions, the average temperature was 74.2°F.

Bonferroni. There were 11 effects in each regression analysis: main effects of photo prime, linear temperature, quadratic temperature, and sex; two-way interactions of Prime × Linear Temperature, Prime × Quadratic Temperature, Prime × Sex, Linear Temperature × Sex, and Quadratic Temperature × Sex; three-way interactions of Prime × Sex × Linear Temperature and Prime × Sex × Quadratic Temperature. Most of these effects are irrelevant to the main hypotheses of this article and were not predicted to yield significant results. The photo prime and quadratic temperature main effects are of particular theoretical interest; alpha was set at .05 for these tests. For the 9 theoretically irrelevant effects, a Bonferroni correction was applied to protect against possible Type I errors. However, because some theoretically irrelevant effects are likely to be of interest in other contexts, we briefly discuss those results that did not meet the Bonferroni correction but did meet standard significance levels.

Major Dependent Variables

State hostility. Analyses revealed a significant quadratic temperature effect on state hostility, $F(1, 409) = 16.94$, $p < .0001$. Figure 2 presents a plot of the best-Fit regression line between quadratic temperature and state hostility ($b_{quad} = .0297$, $a = 67.5$).[3] As predicted, feelings of hostility increased at both hot and cold temperatures, relative to comfortable ones. Also as predicted, there was no effect of photo prime on state hostility, $F < 1$. Indeed,

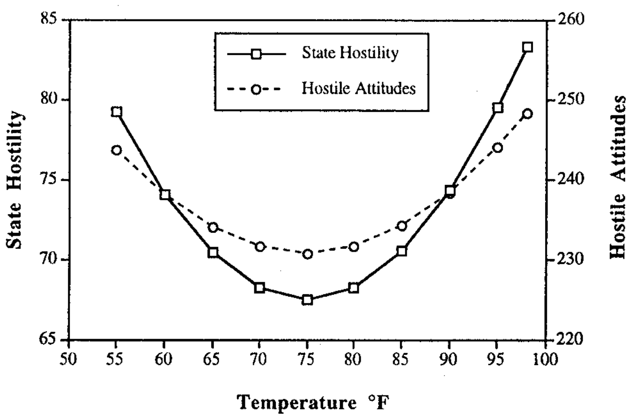

Figure 2 **State hostility and hostile attitudes as a function of temperature.**

none of the other effects even approached significance, *F*s < 2.3, *p*s > .9.

General negative effect. The main effect of quadratic temperature was significant, $F(1, 415) = 8.43$, $p < .005$. As predicted, negative affect increased at uncomfortable hot and cold temperatures, $b_{quad} = .0041$, $a = 11.9$. Also as predicted, photo primes had no impact, $F < 1$. No other effects approached significance, *F*s < 2.2, *p*s > .9.

This quadratic temperature effect resembles the state hostility finding, but it is much weaker. Perhaps general negative affect was increased by uncomfortable temperatures solely because two of the PANAS items directly measure state hostility (*irritable* and *hostile*). When we deleted these two hostility items from the negative affect scale, the quadratic temperature effect became nonsignificant, $F(1, 415) = 2.13$, $p > .14$. Closer inspection of the eight nonhostility items reveals that only two (*upset, distressed*) are general negative affects, whereas the remaining six are specific (e.g., *jittery, afraid*). We therefore used the average of the two general items as a purer measure of general negative affect. Interestingly, there was a significant quadratic temperature effect, $F(1, 415) = 5.02$, $p < .03$. Thus it appears that uncomfortable temperatures do prime general negative affect, though the effect is considerably weaker than the state hostility effect.

Hostile attitudes. Initial analyses revealed this measure to be more closely related to the affective than the cognitive route. We therefore expected uncomfortable temperatures to increase hostile attitudes and photo primes to have no impact. Two significant effects emerged. First, there was a main effect of sex even after applying the Bonferroni correction, males ($M = 252.1$) displayed more hostile attitudes than females (M = 222.9), $F(1, 403) = 14.55$, $p < .0005$. This finding is not at all surprising; it reflects the greater hostility and aggression emitted by males in our society, as well as their more positive attitudes toward violence. Of greater theoretical interest was the significant main effect of quadratic temperature, $F(1, 403) = 5.62$, $p < .02$. As expected, hot and cold temperatures produced increases in hostile attitudes. This finding is particularly impressive in view of the presumed stability of the attitudes being assessed and the fact that they were measured in a comfortable-temperature room. Figure 2 illustrates this quadratic relation ($b_{quad} = .0329$, $a = 231$). Also as predicted, photo prime had no effect, $F < 1$. No other effects approached significance either, *F*s < 1.12, *p*s > .9.

Stroop interference: Aggression versus control. On the basis of the audiotapes, we deleted about 4% of the trials, all those on which subjects made mistakes. Remaining RTs were examined for outliers (Tukey, 1977). The RTs falling outside the inner fences of the boxplot (232, 1,168 ms), about 6%, were deleted from further analyses. For each subject, three RT means were computed, one for each word type. The minimum number of trials for any subject on any word type was 50.

Our main theoretical focus was on the effects of temperature and photo prime on accessibility of aggression words relative to control words. Accessible concepts interfere with performance on this task. We therefore expected subjects in the gun prime condition to take relatively longer to name the color of aggressive words than control words, whereas those in the nature prime condition should be relatively unaffected by word type. To examine this, we subtracted each subject's average control-word RT from that subject's average aggressive-word RT and used our usual regression procedures. The only effect that reached our a priori alpha significance level was the photo prime effect, $F(1, 190) = 4.34$, $p < .04$. As predicted, subjects who viewed guns took 6 ms longer to name the color of aggression words ($M = 698$) than control words ($M = 692$), $t(190) = 3.20$, $p < .002$. Those who viewed nature scenes took only 1 ms longer to name the color of aggression words ($M = 703$) than control words ($M = 702$), $t(190) < 1$, $p > .25$. This provides the first evidence that the weapons effect can operate through automatic priming of hostile thoughts.

The Sex × Quadratic Temperature interaction failed to reach our Bonferroni alpha level but was significant by uncorrected standards, $F(1, 190) = 6.39$, $p < .02$. Separate analyses revealed that there was a quadratic temperature trend for females ($p < .02$) but not for males ($p > .24$). Interestingly, the females' pattern was opposite to what would occur if uncomfortable temperatures primed aggressive thoughts. Because of the large number of statistical tests and the fact that this unexpected one failed to reach the corrected level of significance, we urge readers to interpret it with caution or to regard it as a Type I error. No other effects were significant, *F*s < 3.25, *p*s > .6 (corrected).

These Stroop findings, combined with consistent quadratic temperature main effects on state hostility and hostile attitudes, suggest that when uncomfortable temperatures increase aggression, they do so initially via the affective but not the cognitive route. Similarly, the results suggest that the weapons effect initially operates through the cognitive route but not the affective. The general framework incorporates both phenomena in one general perspective. It also suggests that further work on both of these more specific theoretical effects (i.e., of weapons and temperature) might profitably be directed at the next level in the framework, concerning immediate appraisal effects.

Supplementary Dependent Variables

Perceived comfort. The linear and quadratic effects of temperature on comfort were both significant, $Fs(1, 411) = 29.94$ and 90.84, respectively, $ps < .0001$ ($b_{lin} = .185$, $b_{quad} = -.0262$, $a = 34.7$). Our hot and cold levels were quite uncomfortable. As we have found in other work (Deuser et al., 1991), the most comfortable temperatures were in the 75-80°F range. The cold temperatures were somewhat more uncomfortable than the hot ones. This suggests that in future studies researchers need not use temperatures below 60°F to have cold discomfort roughly equivalent to hot discomfort at 95°F.

The Linear Temperature × Sex interaction failed to reach our Bonferroni corrected alpha level but was significant by uncorrected standards, $F(1, 411) = 4.46$, $p < .04$. This resulted from females' preference for slightly warmer temperatures. No other effects were significant, *F*s < 2.65, *p*s > .9.

Perceived arousal. Regression analyses revealed the expected main effect for the linear temperature term, $F(1, 414) = 50.57$, $p < .0001$. In addition, one unexpected effect was significant even after the Bonferroni correction—the Sex × Linear Temperature effect, $F(1, 414) = 11.59$, $p < .01$. For both males and females, perceived arousal was highest for the colder temperatures and lowest for the hotter temperatures, $ps < .02$. The interaction revealed that the slope relating temperature to perceived arousal was steeper for females ($b_{lin} = -.72$) than for males ($b_{lin} = -.24$).

Positive affect. Positive affect yielded only a significant linear temperature main effect, $F(1, 413) = 17.09$, $p < .001$. The regression line ($b_{lin} = -.147$, $a = 25.0$) revealed that positive affect was highest in the colder temperatures and lowest in the hotter temperatures. The Sex × Linear Temperature effect reached the uncorrected significance level, $F(1, 413) = 5.82$, $p < .02$, though it was nonsignificant by the Bonferroni criterion. The slope relating temperature to positive affect was steeper for females ($b_{lin} = -.210$) than for males ($b_{lin} = -.053$). It is important to note that this PANAS measure of positive affect also assesses arousal. In fact, three items on the positive affect scale are the same as three of our perceived arousal items. We therefore entered perceived arousal scores as a covariate and then reexamined the temperature effect on positive affect. When perceived arousal was statistically controlled, the linear effect of temperature was nonsignificant, $F(1, 412) = 3.31$, $p > .6$ (corrected). The Sex × Linear Temperature interaction also became nonsignificant, $F < 1$. Interestingly, the quadratic temperature effect became significant, $F(1, 412) = 3.90$, $p < .05$ (uncorrected). Adjusted positive affect scores were lower at uncomfortable temperatures than at comfortable ones.

Stroop interference: Escape versus control. If escape-related schemata are primed by uncomfortable temperatures, we should see longer RTs for escape words (relative to control words) in hot and cold temperatures. The same relative interference effect should occur for subjects who viewed guns, if such viewing actually primes escape thoughts. We did not expect either effect, though such priming effects would be interesting. However, neither uncomfortable temperatures nor viewing guns primed escape thoughts in the Stroop task (*p*s > .2). Unexpectedly, the Sex × Photo Prime interaction was significant by the uncorrected criterion, $F(1, 190) = 4.17$, $p < .05$, though it did not reach the more appropriate Bonferroni corrected criterion. Separate analyses of male and female subjects yielded nonsignificant effects of prime in both cases. No other effects were significant, *F*s < 3.1, *p*s > .7.

DISCUSSION

Conceptual Combination of the Major Results

The present research, in conjunction with several other recent works (Anderson et al., 1995; Deuser et al., 1991), reveals numerous findings relevant to the general framework. Although the sheer mass of results can be intimidating, the overall patterns are simple when placed in that framework. More important, integrating these diverse findings within one general framework provides a more unified and understandable picture of the psychological processes underlying affective aggression. Table 2 neatly summarizes the findings.

Affective route. Hot and cold temperatures increased feelings of hostility. Hostile attitudes were similarly affected. These findings suggest that hostile affect is closely linked to discomfort, not just to heat-induced discomfort. In turn, this linkage suggests that properly nonreactive laboratory paradigms, in which equivalent levels of hot- and cold-induced discomfort are manipulated, may pro-

TABLE 2: Summary of Effects of Uncomfortable Temperatures and Picture Primes on the Affective, Cognitive, and Arousal Routes to Aggression

	Temperature Effect		*Picture Prime Effect*	
Dependent Variable	*Hot*	*Cold*	*Guns*	*Nature Scenes*
Negative Affect	↑[a]	↑[a]	No Effect[a]	
Aggressive Cognition Accessibility	No Effect[a]		↑[a]	↓[a]
Physiological Arousal	↑	↓	Not Assessed	
Perceived Arousal	↓[a]	↑[a]	No Effect[a]	

a. Assessed in the present experiment.

duce equivalent increases in aggressive behavior (cf. Boyanowsky, Calvert, Young, & Brideau, 1981-1982). General negative affect was also increased by hot and cold temperatures, though less strongly than hostility. Further work on the specificity versus generality question is warranted.

Also as expected, the weapons effect does not appear to operate via the affective route. Of course, it is always risky to claim that some effect does not occur; perhaps a different procedure would produce the effect. However, the consistency of the temperature effects on the affective variables allows us to safely assume that if the weapons effect operates via the affective route at all, it must do so indirectly and even then only weakly.

Cognitive route. The photo primes produced the predicted aggressive cognition accessibility effect on the Stroop interference task. Viewing guns does automatically increase the relative accessibility of aggression-related thoughts. The lack of a quadratic temperature effect suggests that uncomfortable temperatures do not automatically prime aggressive cognitions. Once again, it is possible that other procedures might result in a temperature priming effect. But the high internal reliability of our Stroop RTs, the large sample size, and the wide range of temperatures we used all lead us to believe that any temperature priming effects are likely to be small at best. Of course, another possibility worth investigating is that uncomfortable temperatures in conjunction with some other aggression-related variable, such as a personal insult or trait hostility, may interactively boost the accessibility of aggressive thoughts.

Arousal route. As expected, the photo prime manipulation had no impact on perceived arousal. Hot temperatures led to decreases in perceived arousal, whereas cold temperatures increased it, replicating previous work. When considered in conjunction with other work showing that hot temperatures increase and cold ones decrease heart rate, these findings suggest that hot temperatures may increase aggression through excitation transfer.

Future Work

Future work in this area could profitably proceed in at least two general directions. First, the hypothesized links between the input variables of temperature and weapons viewing and the second-level variables (cognition, affect, and arousal) are solidly established (see Figure 1). It is now appropriate to move to the next level of the framework, testing links to the results of immediate appraisal processes.

Second, future work should be directed at exploring a wide range of basic input variables and how they exert their influence on aggression throughout all levels of the general framework. Of particular interest are possible interactions among various input variables, such as viewing weapons and personal insults. Although the present results showed no weapons effect on state hostility, we expect that such an effect would be found if the experimental situation also included an ambiguously aggressive personal insult. This general framework has been extremely helpful in guiding our work; we believe that others will similarly benefit from such an overall model.

NOTES

1. It is important to distinguish perception of arousal level from perception of heart rate changes. Zillmann's work is unclear on which of these is more relevant to excitation transfer processes. The two likely correlate quite highly but are somewhat different in conception and in measurement. We have chosen to focus on a general arousal perception.

2. Our specific theory is that cold and hot temperatures should influence hostile affect in the same way, but the archival/field data do not show an increase in aggression in cold temperatures. In our view, this lack of an increase in aggression in cold temperatures results from an asymmetry in humans' ability to compensate for nonoptimal temperatures. People can better compensate for cold temperatures (with clothing, heating) than for hot ones.

3. Recall that all analyses were performed on deviation temperature scores. In all figures, the temperature axis has been reconverted to degrees Fahrenheit after the figure was drawn.

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