

# Discrete Emotions Predict Changes in Cognition, Judgment, Experience, Behavior, and Physiology: A Meta-Analysis of Experimental Emotion Elicitations

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Our purpose in the present meta-analysis was to examine the extent to which discrete emotions elicit changes in cognition, judgment, experience, behavior, and physiology; whether these changes are correlated as would be expected if emotions organize responses across these systems; and which factors moderate the magnitude of these effects. Studies (687; 4,946 effects, 49,473 participants) were included that elicited the discrete emotions of happiness, sadness, anger, and anxiety as independent variables with adults. Consistent with discrete emotion theory, there were (a) moderate differences among discrete emotions; (b) differences among discrete negative emotions; and (c) correlated changes in behavior, experience, and physiology (cognition and judgment were mostly not correlated with other changes). Valence, valence–arousal, and approach–avoidance models of emotion were not as clearly supported. There was evidence that these factors are likely important components of emotion but that they could not fully account for the pattern of results. Most emotion elicitation were effective, although the efficacy varied with the emotions being compared. Picture presentations were overall the most effective elicitor of discrete emotions. Stronger effects of emotion elicitation were associated with happiness versus negative emotions, self-reported experience, a greater proportion of women (for elicitation of happiness and sadness), omission of a cover story, and participants alone versus in groups. Conclusions are limited by the inclusion of only some discrete emotions, exclusion of studies that did not elicit discrete emotions, few available effect sizes for some contrasts and moderators, and the methodological rigor of included studies.

*Keywords:* emotion elicitation, emotion manipulation, emotion theory, discrete emotion

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Although emotion has long been recognized as a driving force in human psychology, it has only recently become a topic of empirical psychological investigation. Despite their recent appearance on the empirical scene, emotions have taken center stage in many investigations as independent variables that influence outcomes ranging from reaction time to prosocial behavior. Emotional constructs are central to modern theoretical models in a number of social sciences, including psychology (Bower & Forgas, 2000; Brown, 2000; Epstein, 1994), economics (Kahneman, 2003; Lerner & Keltner, 2000; Loewenstein, 1996), and philosophy (Haidt, 2001; Rozin, 1999). There has been substantial advancement in the past three decades in the study of the consequences of emotion, but empirical investigation of emotion has been delayed by disagree-

ments over the most effective theoretical perspective for capturing differences among emotional states and methodological uncertainty regarding how to elicit emotions effectively. In an attempt to resolve some of these uncertainties, the purpose of this review was to examine: (a) whether the discrete emotions of happiness, sadness, anger, and anxiety elicit changes in cognition, judgment, experience, behavior, and physiology; (b) whether these changes are correlated as would be expected if emotions organize responses across these systems; and (c) which factors moderate the magnitude of these effects.

## Major Theories of Emotion

Our primary goal in this review was to assess whether discrete emotions elicit changes in cognition, judgment, experience, behavior, and physiology. The expectation that discrete emotions would have unique effects on multiple outcomes arises from a functionalist perspective that describes emotion as an evolutionarily adaptive response that organizes cognitive, experiential, behavioral, and physiological reactions to changes in the environment (e.g., Ekman, 1992; Frijda, 1987; Izard, Levinson, Ackerman, Kogos, & Blumberg, 1998; Lerner & Keltner, 2001; Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005; Pinker, 1997; Plutchik, 2000; Rottenberg, Ray, & Gross, 2007; Tomkins & McCarter, 1964). Most versions of this perspective include the proposition that each

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discrete emotion elicits changes in cognition (e.g., narrowing of attention on a tiger in the distance), judgment (e.g., the risk perceived in the environment), experience (e.g., the recognition that one is afraid), behavior (e.g., a tendency to run away), and physiology (e.g., increased heart rate and respiration) that are adapted to facilitate a response to the types of environmental changes that elicit that emotion. Discrete emotion theories vary, however, in whether they focus on changes in all of these systems or different subsets of these systems. For example, the appraisal-tendency framework stresses changes in cognition and judgment that accompany discrete emotions (Lerner & Keltner, 2001), whereas differential emotions theory stresses the co-occurrence of changes in physiology, emotional expressions, and subjective experience (Izard, 1971; Izard & Abe, 2004). Despite the growing prominence of the functionalist perspective and increasing agreement that emotions elicit changes across multiple systems, there is disagreement regarding this proposition and, in some cases, mixed findings exist. There has been no comprehensive review of empirical findings to address the degree to which there is support for the proposition.

Evidence for the proposition that each discrete emotion elicits changes in cognition, judgment, behavior, experience, and physiology is mixed. Some studies have found that discrete emotions lead to changes in outcomes consistent with the predicted adaptive function of the emotion (Frijda, 1987; Lench & Levine, 2005; Lerner & Keltner, 2001). Limited evidence suggests that these changes may co-occur following an emotion-eliciting event, although the co-occurrence of changes across systems may change across the life span and contexts (Izard & Abe, 2004; Izard, Hembree, & Huebner, 1987; Mauss et al., 2005; Shiller, Izard, & Hembree, 1986). Although there is disagreement about the specific elements within situations that elicit emotional responses, happiness is generally considered to arise from a success (e.g., Fredrickson, 2001; Isen, 2000), sadness from failure or loss with no hope of reinstating the goal (e.g., Frijda, 1987; Gross & Levenson, 1995; Lerner & Keltner, 2001), anger from failure with the possibility of goal reinstatement (i.e., the goal is still possible with additional effort; e.g., Bodenhausen, Mussweiler, Gabriel, & Moreno, 2001; Gross & Levenson, 1995; Harmon-Jones & Sigelman, 2001), and anxiety from the anticipation of threats to important goals (e.g., Frijda, 1987; Gross & Levenson, 1995). The use of specific emotion terms varies considerably among theories and perspectives, and the definitions of discrete emotions used in this review conceptually overlap with some other definitions (e.g., some perspectives describe fear as a discrete emotional reaction to anticipated threats and anxiety as a mood state; some perspectives describe depression as the emotional reaction to loss rather than sadness). To the extent that emotions represent discrete constructs, each emotion should differ from other emotions (and neutral groups) on measures of cognition, judgment, experience, behavior, and physiology, and the differences should co-occur across these systems.

Alternative theories of emotion predict, and there is empirical evidence to suggest, that valence or valence combined with arousal captures the important differences among emotions (e.g., Barrett, 1998; Russell, 1980; Watson & Tellegen, 1985). If valence effectively captured differences among emotions, sadness, anger, and anxiety would be expected to have similar effects on outcomes because they are emotions characterized by negative valence. Although there are some discrepancies among models that include

both valence and arousal, most models place anger and anxiety very close to one another in terms of valence (negative) and arousal (high; Feldman-Barrett & Russell, 1998; Larsen & Diener, 1992; Russell, 1980; Watson & Tellegen, 1985). If valence and arousal effectively captured differences among emotions, anger and anxiety would be expected to have similar effects on outcomes. These accounts sometimes further posit that observed differences among discrete emotions arise from cultural expectations regarding emotions (e.g., people expect anger and anxiety to be different) rather than from a true difference in emotional reactions (Barrett & Russell, 1999). This possibility cannot be directly addressed in the present investigation. However, if differences were due to beliefs about emotions, differences among discrete emotions would be expected to be most evident in self-reports of emotional experience that are at least partially based on general beliefs about emotional experience (Robinson & Clore, 2002) and least evident for other outcomes, such as behavioral and physiological reactions.

Finally, some models of emotion suggest, and studies have found, that approach and avoidance motivations determine responses to situations, although there is debate about the emotions associated with each motivation (Bechara, Damasio, Tranel, & Damasio, 1997; Carver, 2004; Gray, 1972). In several models, positive emotions reflect approach motivations and negative emotions reflect avoidance motivations (Bechara et al., 1997; Gray, 1972). The same predictions would be derived from these models as from the valence models described previously. In other models, happiness and anger reflect approach motivations and sadness and anxiety reflect avoidance motivations (Bodenhausen, Sheppard, & Kramer, 1994; Harmon-Jones, 2003; Henriques & Davidson, 1991). If these distinctions effectively captured differences among emotions, one would expect emotions of a similar motivational direction (happiness and anger; sadness and anxiety) to have similar effects on outcomes and emotions of different motivational directions (happiness, anger vs. sadness, anxiety) to have different effects on outcomes.

The present investigation allowed for a test of the general proposition that discrete emotions lead to changes in cognitive, judgment, experiential, behavioral, and physiological outcomes and for an examination of support for a number of predictions about the most efficient way to capture differences among emotions. It is important to note that there are some predictions related to the discrete emotions perspective that cannot be evaluated in this review, including the degree to which changes in different systems facilitate a functional response to the environment. Thus, our primary purpose in this review was to examine the effects of discrete emotions across outcomes and the extent to which these changes co-occur across systems.

### Major Types of Elicitations and Related Issues

The other primary goal in the present review was to provide practical information on moderators of these effects, in particular factors associated with emotion elicitations. There is great variation in the types of elicitations used to manipulate emotional states in experimental research designs, and researchers must either adopt a method from another researcher or develop their own idiosyncratic methods. Often, they must make this choice with little empirical guidance regarding the effectiveness of different

methods (Rottenberg et al., 2007). Several reviews have been conducted on positive versus negative mood elicitations and have generally found that most techniques to induce mood are effective (Gerrards-Hesse, Spies, & Hesse, 1994; Westermann, Spies, Stahl, & Hesse, 1996), but there have been no reviews of elicitations of discrete emotions. In the text below, general classifications of emotion elicitation techniques are defined and a brief overview of practices and potential issues is presented for each type of elicitation. It is important to note that the limitations of the methods used to elicit emotions necessarily curtail the validity of the effects included in the present review.

## Film

Film emotion elicitations typically consist of showing participants a brief video clip, often a portion of a feature-length film, that is intended to elicit discrete emotions. This elicitation is an attractive alternative, because video clips are relatively short, intuitively powerful, and easily accessible and the clips and the procedure for viewing them can be standardized across participants (Kring & Gordon, 1998; Rottenberg et al., 2007). Another advantage of film elicitations is the availability of standardized video clips that reliably elicit different emotional reactions (e.g., Gross & Levenson, 1995; Philippot, 1993; Rottenberg et al., 2007). There are also several potential disadvantages to the use of video clips. Some emotions, such as anxiety, appear particularly difficult to elicit with films (Gross & Levenson, 1995). Further, individual differences and prior experiences with the films may moderate participants' reactions to video clips (Gross, 1998; Larsen & Ketelaar, 1991). An additional issue regarding the use of films is that they have typically been validated by self-reports of the intensity of experienced emotion. It is unclear whether films elicit changes in other systems, particularly as reactions in cognitive, judgment, experiential, behavioral, and physiological outcomes are often loosely coupled (e.g., Bradley & Lang, 2000; Mauss et al., 2005; Weinstein, Averill, Opton, & Lazarus, 1968). Further, films are cognitively complex stimuli that may prime cognitions in addition to those related to the emotion and that depict emotional situations happening to another person in a fictional setting. To be effective, such elicitations may require that participants be willing to engage in the fictional reality, and it is debatable whether emotions elicited by film viewing are similar to daily emotional experience (even the most devout horror buff would presumably not enjoy being chased by an axe-wielding maniac; e.g., Silvia, 2005; Walters, 1989). An additional issue with the use of video clips is that, although the presentation of each clip can be standardized, it is difficult to standardize across clips because films often differ from one another in multiple details that may impact outcomes (e.g., the number of people, colors used, background music).

## Pictures

The supraliminal presentation of pictures is also used to elicit emotional reactions. The most commonly used pictures come from the International Affective Pictures System (IAPS; Bradley & Lang, 2007; Center for the Study of Emotion and Attention, 1995; Lang, 1995), a set of pictures that has been standardized on valence, arousal, and dominance dimensions. The advantages and

disadvantages with picture elicitations are similar to those associated with the use of video clips. An additional disadvantage to the use of pictures from the IAPS to elicit discrete emotions is that the images are intended to elicit changes in valence and arousal, not discrete emotions, and individuals vary in the emotional responses they report to the images (Bradley & Lang, 2007). There have, however, been recent attempts to identify standardized sets of images that elicit discrete emotions (Mikels et al., 2005).

## Priming

Priming elicitations present stimuli outside of participants' conscious awareness; they often consist either of subliminal presentation of pictures or words or of exposure to words through subtle tasks, such as unscrambling anagrams or crossword puzzles. The assumption is that these stimuli activate or "prime" related constructs in memory and thus elicit the emotion related to the stimuli (e.g., Bargh & Gollwitzer, 1994). The advantage to priming emotions is that the elicitation occurs outside of awareness and that demand characteristics therefore should be minimal. Potential disadvantages include ambiguity about whether emotions are primed or are simply related cognitions, as well as the lack of standardization between conditions and studies. Researchers frequently construct their own priming stimuli, based on stimuli that have been successful in other priming studies. They typically use primes that appear intuitively linked to the emotion concept (e.g., a picture of an extended middle finger or a crossword puzzle containing words such as *hot* and *frustrate* to prime anger).

## Music

In music elicitations, participants listen to musical selections, sometimes following instructions that they should attempt to simulate the emotion intended by the music (Clark, 1983; Västfjäll, 2002). Music elicitations were developed to elicit mood states and appear to do so effectively when positive and negative mood states are compared with one another (the effects are less consistent if mood states are compared with a neutral group and with behavioral measures versus self-report measures; Albersnagle, 1988; Clark, 1983; Kenealy, 1988; Martin, 1990; Västfjäll, 2002). There is disagreement regarding whether music can theoretically elicit discrete emotions (defined as relatively brief, intense states); however, music has been used with the intention to elicit discrete emotions, including anger and anxiety, and these studies are included in the present review (e.g., Västfjäll, 2002). Like films and pictures, music elicitations are attractive because the presentation can be standardized across participants, and there are selections that have been developed to reliably elicit particular states. The disadvantages to the use of music are similar to those for films and pictures, including the difficulty of standardizing music selections across emotional conditions and the potential need for participants to willingly engage with the stimuli (Scherer & Zentner, 2008; Silvia, 2005; Walters, 1989). Additional issues arise from the practice of including instructions to simulate the emotion, because these instructions may produce demand effects and participants may vary in strategies they employ to achieve the emotional state (Kenealy, 1988; Mayer, Gayle, Meehan, & Haarman, 1990; Västfjäll, 2002). Another potential disadvantage to the use of music is that most selections are classical music (likely because they have

no vocals), but few college participants are likely to prefer classical music over other forms of music. The emotional implication of forcing participants to listen to nonpreferred music is not well understood.

### Velten

The original Velten elicitation consisted of self-referent statements designed to be increasingly positive, negative, or neutral. Participants received instructions to put themselves in the target mood state and then read each statement for a specified period (Polivy, 1981; Velten, 1968). Reviews have suggested this technique effectively elicits positive and negative mood states on self-report measures (results are less consistent for behavioral measures; Kenealy, 1986; Larsen & Sinnett, 1991). Studies that included Velten elicitations as elicitors of mood were not included in this review. Velten-like elicitations have recently been developed to elicit discrete emotions, including anger and anxiety, and studies with the intent to elicit discrete emotions were included in this review (Carter et al., 2002). The advantages to Velten elicitations include the standardized presentation of sentences, although there are variations in the number of statements provided and the exact instructions given (for a review, see Kenealy, 1986). As for the other elicitations described thus far, potential disadvantages include the presence of demand characteristics (Clark, 1983; Polivy & Doyle, 1980) and potential priming of concepts by the content of the elicitation rather than an evoked emotion (Västfjäll, 2002).

### Imagination

Emotion elicitation techniques that involve imagination typically ask participants to listen to or read a scenario while they imagine themselves in that situation (e.g., Miller, Patrick, & Levenston, 2002; Velasco & Bond, 1998). This technique has the advantage of allowing participants to draw on their idiosyncratic experiences while at the same time offering some standardization. Potential disadvantages include demand effects resulting from the emotional tone of the imagined scenarios, the possibility that participants must be willing to place themselves in the emotional state associated with the fictional scenario, and the risk of priming content rather than eliciting emotion.

### Reading Text

Elicitations that include reading texts consist of participants reading standardized text intended to elicit an emotional reaction. The texts range from newspaper clippings describing recent events to portions from textbooks or novels. Potential advantages include standardized materials and presentation as well as the fact that participants are familiar with the media. Here, as with other elicitations that include specific information, there is the risk that the elicitations prime cognitive material rather than elicit emotions. In addition, reading some forms of text, such as an excerpt from a novel, may require a willingness to engage in a fictional environment.

### Behavioral

Behavioral emotion elicitations encourage participants to behave in a particular way with the intention of eliciting discrete

emotions (Laird & Strout, 2007). These elicitations range from asking people to breathe as if they were experiencing a particular emotion to encouraging people to activate the same muscles involved in an expression typical of an emotional state (e.g., frowning). Potential advantages to behavioral elicitations include that emotions are elicited with minimal demand characteristics (depending on how participants are encouraged to alter their behavior), that the elicitation involves participants directly and does not require a willingness to engage with a fictional scenario, and that there is little to no cognitive content involved in the elicitation. Potential disadvantages include the difficulty of standardizing the elicitation across participants and that these types of elicitations appear to elicit emotions in only a portion of participants (Laird, 1984; Laird & Crosby, 1974).

### Real-Life Manipulations

Real-life manipulations include procedures designed to elicit emotions through a situation experienced directly by participants. For example, a confederate may insult a participant in the hallway outside of a room where outcome measures will be completed (Eckhardt & Cohen, 1997). These types of elicitations are appealing because they involve the participant in situations that evoke emotions in daily life and thus seem intuitively likely to elicit strong emotions. In addition, if they are executed well, these types of elicitations are less likely than other elicitations to arouse participant suspicions or to elicit demand effects from participants who are not even aware that they are taking part in an emotion elicitation (Harmon-Jones, Amodio, & Zinner, 2007). Potential disadvantages with these elicitations include ethical issues related to the fact that participants cannot be fully informed about the study beforehand and the difficulty in standardizing the presentation of a relatively complex task that often includes social interaction with a confederate.

### Autobiographical Recall

In autobiographical recall elicitations, participants are typically instructed to recall and often to write about a past event that elicited intense happiness, sadness, anger, or anxiety or a neutral event (often an ordinary day or neutral event, such as grocery shopping; e.g., Lench & Levine, 2005; Lerner & Keltner, 2001). The time frame in which the recalled event could occur ranges from days to a lifetime, and the time allotted to recall the event also varies from a few minutes to unlimited time. Potential advantages to this elicitation include the lack of any specific cognitive content and reliance on real events that elicited intense emotions. Potential disadvantages include that emotional reactions evoked by recalling past events may not be equivalent to current emotional experience and that participants must willingly engage in the recollection. There is also evidence that writing about past emotional events can lessen the intensity of emotional reactions to those events (Pennebaker & Chung, 2007), and it is unclear how this might influence reactions to experimental elicitations.

### Key Definitions and the Scope of the Review

Although our purpose in this review was to evaluate evidence of discrete emotions, it was necessary to develop an a priori definition

of emotion in order to identify relevant articles and specify the scope of the review. There has been growing consensus regarding the definition of emotion, often through comparison to mood and affect. Following this consensus, *emotion* was defined as a relatively brief and intense state in reaction to a specific experience or event that lasts a few seconds to several minutes (e.g., Clore, Schwarz, & Conway, 1994; Eich, Kihlstrom, Bower, Forgas, & Niedenthal, 2000; Ekman, 1992; Rottenberg et al., 2007; Russell, 1991). In contrast, *moods* and *affect* were defined as relatively long-lasting states less tied to a specific experience (Russell, 2003). Emotion, so defined, was the focus of this review, and the above definitions were used when identifying articles for inclusion in the review. The review therefore focused on studies that included emotion elicited by a specific experience as an independent variable, and it examined concurrent or subsequent changes in cognition, judgment, experience, behavior, or physiology.

There is disagreement about which emotions are discrete and represent independent categories of emotional experience, and, more fundamentally, there is disagreement about whether emotions represent discrete constructs beyond their valence and arousal or relation to approach and avoidance motivation. This review focused on happiness, sadness, anger, and anxiety because these emotions were elicited in numerous studies, allowing for comparisons of the effects of different discrete emotions on outcomes. Inclusion of these emotions also allowed tests of predictions derived from several theories of emotion. A discrete emotion perspective suggests that each emotion is discrete in the sense that it has unique causes and consequences. The inclusion of multiple negative emotions (sadness, anger, anxiety) meant that the possibility that valence and/or arousal, rather than discrete emotions, accounted for effects could be assessed. A review of potential discrete positive emotions was not possible because few studies included more than one of these emotions (Bonanno & Keltner, 2004). Multiple approach emotions (happiness and anger) and avoidance emotions (sadness and anxiety) were included in order to assess the possibility that approach or avoidance motivations might best account for differences among emotions.

In this review, outcome measures were considered to be cognitive, judgment, experiential, behavioral, or physiological outcomes. Each of these broad outcome categories includes multiple specific outcomes and measures that could each serve as the focus of a separate review. We chose to focus on the fundamental issue of whether emotions elicit changes across systems, and we therefore classified outcomes within relatively broad categories. Cognitive outcomes, considered to be measures of thought processes, included measurements such as recall, attention, and accuracy of identifying stimuli. Judgment outcomes, considered to be measures of subjective interpretation, included measurements such as perceived risk, preference for an interaction partner, and ratings of the positivity of stimuli. Judgment outcomes were considered separately from cognitive outcomes, both because judgments are typically ratings of belief or attitudes, whereas cognitive outcomes typically indirectly assess thought-related processes, and because judgments are sometimes considered a behavior. Experiential outcomes were considered to be self-reports of emotional experience; they included measurements such as the intensity of experienced happiness and sadness. Behavioral outcomes were considered to be observable actions taken by the individual; they included measurements such as facial expression and the amount of hot sauce sent

to an interaction partner. Physiological outcomes were considered to be physical changes that may or may not be directly observable without specialized equipment; they included measurements such as temperature and heart rate (brain and hormone measurements were excluded because of difficulty interpreting these data and the exploratory nature of these tests). The outcome categories used in this review were intentionally broad and were intended to capture a range of potential reactions associated with emotions.

### Potential Methodological Moderators of Emotional Responses in Experiments

In order to address some of the potential concerns outlined above for various elicitations and to identify practical issues related to the elicitation of emotion, we examined several potential moderators of emotional responses. The age, gender composition, culture, and population (college students vs. community members) of participants were included in the present review. Older adults tend to report less intense negative emotions than younger adults do after a number of experiences (Carstensen, Fung, & Charles, 2003; Charles & Carstensen, 2008). The average age of participants may therefore influence elicitation effectiveness, and it was included as a potential moderator. The proportion of female participants may also influence the effectiveness of emotion elicitations, and this potential moderator was included. Women tend to report more frequent and intense experience of emotion than men do (Bradley, Codispoti, Sabatinelli, & Lang, 2001). Although women are more emotionally expressive in general, men are believed to express certain emotions, particularly anger, more than women do (e.g., Cox, Stabb, & Bruckner, 1999; Lench, 2006). This is likely due to the socialization of what is considered appropriate within culturally determined gender roles (Grossman & Wood, 1993) but may reflect evolutionarily adapted changes specific to gender. Cultural differences are also an important factor in determining the experience and expression of emotion and were therefore examined. Cultures vary in the value placed on different emotions as well as the extent to which there is variation of value within the culture. Western cultures tend to be more homogeneous in that there is a consistently high value placed on positive emotions, whereas people within eastern cultures have more varied experience (Chentsova-Dutton & Tsai, 2007; Eid & Diener, 2001; Tsai, Levenson, & McCoy, 2006). Due to constraints in the number of cultures represented in published articles, culture was roughly approximated by identifying whether participants were from the United States or other countries. Whether participants were college students or community members may also be associated with the effectiveness of emotion elicitations and therefore was included. College students often are enrolled in psychology courses and complete studies in partial fulfillment of course requirements. Student participants may therefore experience demand characteristics and have insight into study hypotheses to a greater extent than community members (Sears, 1986).

Although some elicitation techniques appear to have stronger demand characteristics than others, whether demand effects are partially responsible for the apparent effects of emotion elicitations is a broader concern. Cover stories are typically included in order to make the purpose and predictions of the study less evident and thus reduce demand effects that might artificially inflate the effect associated with manipulations. Whether a cover story was offered

for the emotion elicitation was thus examined. Some articles included specific cover stories (e.g., that there were two studies, one regarding recall of past experience and another with the outcome measure); other studies included sleight of hand that made the elicitation less obvious (e.g., an apparently unaffiliated person insulting participants in the hallway). These nuances could not be efficiently captured through coding; therefore, whether or not any cover was present was included. In addition, whether or not the researchers excluded participants on the basis of their responses to the emotion elicitation was included, because this exclusion would make elicitations appear more effective than they were for the entire sample population. The exclusion of participants ranged from throwing out all women because the elicitation did not work with them to throwing out a handful of participants who distracted themselves from the elicitation (e.g., doing push-ups; walking around the cubicle; Niedenthal, Halberstadt, & Setterlund, 1997). Whether participants completed the emotion elicitation alone or in a group was also included. Participants may be more likely to use some emotion regulation strategies, such as distraction, when in a group. Between- and within-subject comparisons were included in the review, and a variable was included to represent this characteristic. Although the internal validity of within-subject designs is easily threatened (Shadish, Cook, & Campbell, 2002), within-subject designs are typical in some areas of research (e.g., psychophysiological research; Stemmler, Heldmann, Pauls, & Scherer, 2001). It appeared more comprehensive to include these areas and account for the contribution relevant to type of contrast rather than to exclude the research area completely.

### Summary of the Present Investigation

The present investigation was intended to address whether happiness, sadness, anger, and anxiety elicit changes across cognitive, judgment, experiential, behavioral, and physiological systems; whether these changes co-occur; and which factors moderate differences among discrete emotions. We conducted a meta-analysis to address these questions by examining effect sizes from comparisons among discrete emotions for cognitive, judgment, experiential, behavioral, and physiological outcomes and moderators of these effects. We also examined the influence of participant age, gender, country, and population as well as a number of methodological factors. The intention was to evaluate the evidence related to predictions for discrete emotion comparisons that can be drawn from various theories of emotion and to provide practical information about factors that influence emotion elicitation for researchers interested in using emotion as an independent variable.

## Method

### Selection of Studies

Searches were conducted for potentially relevant studies with the criteria that articles included the keywords *emotion*, *hap*\*, *ang*\*, *anx*\*, or *sad*\*; were not dissertations; and were written in English. The specific emotion keywords were further limited by specifying that the article included one of the following keywords: *manip*\*, *elicit*\*, *induct*\*, or *influen*\*. We reviewed all articles with the keyword *sad*\* in the year 2009 twice, once using just the

keyword *sad*\* and once adding the manipulation keyword restrictions above. Both searches resulted in the same articles that met criteria for inclusion. Thus, inclusion of the additional keywords effectively limited retrieved articles that were unlikely to be included in the final review and allowed us to expedite the review process. Searches were run in PsycInfo from the earliest available articles (1872) through the end of 2009 (retrieval dates in May and June, 2010). The relatively broad keywords identified above were used to allow for the identification of articles that elicited emotion to examine the effects on other outcomes that were the primary focus of the investigation. Dissertations were excluded during the database search because the additional search would have been prohibitively costly. Only articles written in English were included because of the language abilities of this review's authors. Only the PsycInfo database was searched because additional searches would have been prohibitively time consuming and because preliminary searches conducted in MEDLINE and ERIC suggested that very few studies would meet inclusion criteria (e.g., manipulating multiple discrete emotions). This search identified 58,280 articles that potentially met criteria for inclusion in the review.

The titles and then abstracts of these articles were reviewed to determine their eligibility for the review. This initial review was extremely inclusive, and articles were excluded at this stage only if the abstract clearly indicated that the article did not meet criteria (e.g., if it was evident that the subjects were rats). If there was any doubt as to the eligibility of the article, the article was retained for further review. This review of the abstracts identified 1,544 articles that potentially met inclusion criteria. Each of these articles was reviewed in full and was coded or excluded because it did not meet criteria upon this closer examination. A call for additional papers and unpublished data was made through two e-mail distribution lists relevant to scientists that frequently elicit emotions (the Society for Personality and Social Psychology and the International Society for Research on Emotion), and direct requests were made to researchers who frequently use emotion elicitations in published reports. This call yielded seven additional papers or descriptions of unpublished data, three of which met criteria for inclusion.

Articles were excluded based on the following criteria: (a) the discrete emotions of happiness, sadness, anxiety, or anger were not examined (articles that dealt with general positive and negative affect or mood only were not included because they did not fall within the scope of this review);<sup>1</sup> (b) no comparison groups were included for happiness, sadness, anger, anxiety, or neutral groups that were the focus of this review (i.e., only one emotion elicited); (c) no emotion was elicited; (d) no empirical data were presented in a format that yielded information about means or effect sizes (e.g., reviews, qualitative analyses); (e) animals or children were used as participants (the materials that elicit emotional reactions may well differ between children or animals and adults; e.g., Levine, 1995; Reichenbach & Masters, 1983); or (f) data were

<sup>1</sup> Emotion researchers vary in their terminology, and therefore articles were excluded on the basis of the methodological description rather than terminology (e.g., a study that focused on "negative affect" would be included if participants were shown pictures consistent with sadness but would not be included if participants were shown pictures consistent with multiple emotions such as disgust, anger, and sadness).

redundant with another published source. Participants with severe psychopathology (e.g., schizophrenia) were excluded, although these studies typically included a control group that met inclusion criteria and were therefore included in the review. Participants with depression and anxiety were included because these are common disorders and are particularly prevalent in college students, the most frequently used population. All analyses remain the same if these studies are excluded. Participants with subclinical levels of disorders were also included.

Out of the 1,547 articles reviewed in full (1,544 from database searches and three from researcher solicitations), 1,037 articles were excluded for the following reasons: 743 did not elicit the discrete emotions identified for review, 115 elicited only one emotion, 76 did not include sufficient information to calculate effect sizes, 49 reported no empirical data, 35 had no outcome measure, three had effect sizes that were redundant with another source, seven used animal or child participants, two were noted by the journal that published the article as containing faked data, and seven were not retrievable. In order to assess the reliability of article identification strategies, three coders (one PhD level and two master's level) used the exclusion criteria to identify relevant articles in a subset of the identified titles (with the keyword *sad*\* in 2009; 59 articles). Each coder worked independently to identify articles ( $\kappa = 91\%$ ,  $92\%$ , and  $92\%$ ; eight articles were ultimately included). Overall, 687 studies were identified from 510 sources that elicited discrete emotions in adults.

### Variable Coding

Coding of study variables was completed by two trained coders (one PhD level and a trained research assistant). Each coder independently reviewed each full article as many times as necessary to code all study variables. No discussion took place during this initial coding in order to encourage independent coding of the study variables. These coders reached the following agreement on coding (reliability of these codes was assessed with Pearson's correlation for continuous variables and a kappa coefficient for categorical variables): type of elicitation ( $\kappa = 0.97$ ), emotions elicited and contrasted ( $\kappa = 1.00$ ), mean age ( $r = 1.00$ ), proportion of women ( $r = 0.97$ ), country of participants ( $\kappa = 1.00$ ), population (college student vs. community member,  $\kappa = 1.00$ ), presence of a cover story ( $\kappa = 0.94$ ), whether participants were excluded ( $\kappa = 1.00$ ), and whether participants took part in a group ( $\kappa = 0.71$ ). The lead author coded the outcome associated with each effect size, the type of contrast (between vs. within), and extrapolated effect sizes. The coders then met to resolve coding discrepancies. During these meetings, the coders discussed discrepancies and resolved them by scrutinizing the original source article to determine which code was consistent with the published text. All characteristics included in this review were coded according to statements available in the published texts. Unlike coding that involves a subjective rating of study characteristics, coding in this study required little or no subjective judgment. The process of discussion and consultation of articles therefore resolved all discrepancies (Cooper, Robinson, & Patall, 2006; Pascoe & Richman, 2009).

**Outcome characteristics.** Discrete emotions are theorized to elicit changes across systems and to affect the ways that people think, judge, feel, behave, and react. We therefore sought to

include outcome categories that captured each of these domains. For this review, outcomes were coded as cognitive outcomes (i.e., memory, accuracy, creativity, perception); judgment outcomes (i.e., judged positivity, preferences, risk judgments; these were considered separately from cognitive outcomes, because they typically consist of ratings rather than indirect measures of process and judgments are sometimes considered behaviors); self-reported experiential outcomes (i.e., self-reported anger, anxiety, happiness, sadness, or arousal); behavioral outcomes (i.e., facial expression, choice, reaction speed, particular action); and physiological outcomes (i.e., respiration, heart rate, EMG readings, skin conductance, temperature). Studies that measured physiological outcomes often included multiple scores that were derived from the same physiological measurement (e.g., respiratory sinus arrhythmia scores—RSA—are derived from measures of heart rate and respiration rate, and all three outcomes might be reported). In this case, only the untransformed measurement was included when available in order to avoid redundancy (e.g., heart rate and respiration rate). If the untransformed measurement was not included, redundancy was not a concern, and the transformed measurement was included (e.g., RSA).

**Elicitation characteristics.** The type of elicitation was coded using the descriptions given above in the introduction. These included film, picture presentation, priming, music, Velten-like statements, imagination (this included one virtual reality manipulation), reading text, behavioral, real-life experiences, and autobiographical recall.

**Emotions elicited.** Researchers vary in their use of emotion terms, and emotions thus were coded in accordance with the descriptions outlined in the introduction. Elicitations that involved the experience of success were coded as happiness elicitations; those that involved the experience of loss without hope of reinstating the goal were coded as sadness elicitations; those that involved the experience of loss with the possibility of goal reinstatement were coded as anger elicitations; and those that involved the experience of threat to goals were coded as anxiety elicitations. There is disagreement regarding whether certain types of elicitations fulfill these criteria and could be considered to elicit discrete emotions. For example, researchers have argued that films and images can elicit emotions such as happiness because viewers engage with the goals of the protagonists; other researchers might define positive emotion elicited by film or images as amusement rather than happiness (Gross & Levenson, 1995). We included in this review all elicitations that attempted to elicit discrete emotions and coded them according to the assumption that viewers can engage in goals of protagonists or with images of nonpresent stimuli (the effect sizes associated with different elicitations can be viewed to examine the extent to which such elicitations influence outcomes). This review focused on anxiety, considered to result from the perception of potential threats to important goals (e.g., contemplation of an upcoming speech), rather than fear, considered to result from experiencing ongoing threats to important goals (e.g., one's chair suddenly dropping backward), in part because relatively few studies include fear elicitations thus defined (some studies included elicitations of fear that fit the definition of anxiety used in this review and were coded accordingly). Similarly, happiness was the only positive emotion included in this review, because relatively few studies include multiple discrete positive emotions.

**Methodological moderators.** Several potential moderators of the efficacy of emotion elicitations were coded. Attempts were made to code several characteristics that may influence the efficacy of emotion elicitations, but this information was available for only a small subset of studies; therefore, these characteristics could not be included as potential moderators. These included ethnicity, the specific outcome measure, the reliability of the outcome measure, and individual difference characteristics (e.g., depression, extraversion). The average age of participants and the percentage of female participants were coded. When the numbers rather than percentages of male and female participants were reported and it was clear from the description that a few participants did not report their gender, the actual percentage of identified female participants was calculated. The country in which the data were collected (the United States vs. other countries) was used as a rough proxy for the culture of participants. If this information was not reported in the study description, it was assumed that data were collected at the university with which the first author was affiliated. Whether participants were college students or community members was coded. Because college students are the most common convenience sample (Sears, 1986), it was assumed that participants were college students if no recruitment information was reported in the study description.

The presence of a cover story for the emotion elicitation was coded. Cover stories were defined broadly to include any attempt to disguise the intent of the study or emotion elicitation, ranging from elaborate deceptions to mildly misleading statements. If no information was included about a cover story, it was assumed that no cover was present (in many of these cases, participants were explicitly instructed to foster the target emotion, and a convincing cover story would have been difficult to construct). In addition, whether or not the researchers excluded participants on the basis of responses to the emotion elicitation was coded. If no mention was made of participant exclusion, it was assumed that all participants were included. Whether participants completed the emotion elicitation alone or in a group was also coded. It was assumed that participants in studies that focused on physiological outcomes took part individually, even if this was not specified, because of the cost and sensitivity of most monitoring equipment. Participants separated by cubicle walls were also coded as taking part individually. Between- and within-subject comparisons were included in the review and were coded accordingly. When multiple groups were available for the same outcome and comparison (e.g., discrete emotions were compared with a neutral baseline and a neutral group of participants), the between-subjects comparison was chosen for inclusion. Some studies included both a between- and a within-subject component in the sense that different groups of participants were assigned to emotion conditions, but reported scores represented changes from a neutral baseline (e.g., anger before an elicitation subtracted from anger after an elicitation in anger and neutral conditions). If only the difference score was reported, these studies were coded as between-subjects designs and the change score was used to calculate the effect size.

### Extrapolating and Calculating Effect Sizes

Hedges'  $g$  was used as the effect size because it provides a more precise estimate of variance than is typically associated with Cohen's  $d$  (e.g., Hedges & Olkin, 1985; Rosenthal, 1991). For the

purposes of interpreting the magnitude of the observed effects, effect sizes of .2 are considered small, of .5 are considered medium, and of .8 are considered large. The program Comprehensive Meta-Analysis (Version 2; CMA; Biostat, 2005) was used to order, calculate, and compare effect sizes. Effect sizes were calculated from mean scores on a particular outcome associated with a discrete emotion (happiness, sadness, anger, and anxiety) compared with mean scores on that same outcome associated with a different discrete emotion or neutral condition. In studies with a between-subjects design, the effect size was calculated from mean scores on an outcome in one emotion condition (e.g., self-reported anger in the anger condition) compared with mean scores on the outcome in another emotion condition (e.g., self-reported anger in the neutral condition). In studies using a within-subject design, the effect size was calculated from mean scores on an outcome after one emotion elicitation (e.g., self-reported anger after the anger elicitation) compared with mean scores on the outcome after a different emotion elicitation (e.g., self-reported anger after the same person completed a happy elicitation). When the information was available in text, table, or figure, effect sizes were calculated from means and standard deviations. If descriptive statistics were not available, standard formulas were used to convert inferential statistics (typically a  $t$  test) into effect sizes; if inferential statistics were unavailable, standard formulas were used to convert associated  $p$  values into effect sizes (for these formulas and procedures, see Borenstein, Hedges, Higgins, & Rothstein, 2009). If the effect was reported as nonsignificant but no specific information was provided, effect sizes were estimated by presuming  $p = .50$ . If the effect was reported as significant without additional information, effect sizes were estimated by presuming  $p = .05$ , a likely conservative estimate because most actual  $p$  values would be smaller and would be associated with a larger effect size (Borenstein et al., 2009; Rosenthal, 1995).

Effect sizes were calculated for comparisons between neutral, happiness, sadness, anger, and anxiety conditions involving measures of cognition, judgment, experience, behavior, or physiology. This yielded a total of 4,946 effect sizes. When multiple outcomes or contrasts were assessed within the same study, CMA calculates the mean effect size and associated combined variance for a study in order to correct for the dependency of these effects (Borenstein et al., 2009; Hunter & Schmidt, 2004). For each study, the mean effect size was calculated as

$$\bar{Y} = \frac{1}{m} \sum_j Y_j$$

In this formula,  $m$  is the number of effects calculated within each study,  $Y$  is the effect size for each outcome or contrast, and  $j$  represents the  $j$ th effect calculated within that study. CMA calculates the combined variance in order to provide statistics related to the heterogeneity of an effect and inferential analyses to assess whether the mean effect sizes in two or more groups significantly differ from one another (similar to an ANOVA). For each study, the combined variance was calculated as

$$V_{\bar{Y}} = \left( \frac{1}{m} \right)^2 \left( \sum_{j=1}^m V_j + \sum_{j \neq k} (r_{jk} \sqrt{V_j} \sqrt{V_k}) \right)$$

In this formula,  $m$  is again the number of effects calculated within each study,  $V$  is the variance for each outcome or contrast, and  $r$  is the correlation between the effect sizes. It was typically impossible to determine the correlations among effect sizes from the original articles (this would require reports of correlations among scores on all outcomes or contrasts). Therefore, CMA assumptions were used, because they result in conservative estimates of homogeneity for overall effects and comparisons among groups ( $r = 1.00$  for overall effect size calculation;  $r = 0.00$  for ANOVA-type analyses; Borenstein et al., 2009).

Random-effects models were calculated because variation in effect sizes among studies was assumed to occur as the result of random sampling error as well as differences between groups or individuals (Cooper & Hedges, 1994). The random effects model therefore allows generalizations about the effects across a population rather than only to past studies (Raudenbush, 1994). Random effects models can create small-sample bias (studies that have small samples and large effects will have a relatively large influence on the overall effect size estimate; Borenstein et al., 2009). CMA offers a correction for small-sample bias by weighting the effect size associated with studies by sample size (Hedges & Olkin, 1985), and this correction was applied in analyses ( $N$  = sample size):

$$g = 1 - \frac{3}{4(N - 2) - 1}$$

The  $Q$  statistic was used to assess heterogeneity in the variance among the effect sizes, and, when significant, moderators were evaluated to explain the heterogeneity. Categorical moderators were evaluated with the  $Q_{\text{Between}}$  ( $Q_B$ ) statistic at the  $p = .05$  level of significance. When significant,  $Q_B$  indicates that the effect sizes differ among the levels of the categorical moderator (Borenstein et al., 2009). We evaluated the relationships between continuous moderators and effect sizes using the meta-regression program within CMA with a maximum likelihood estimation procedure (Borenstein et al., 2009; Greenland, 1994; Hedges & Vevea, 1998; Thompson & Higgins, 2002). With this procedure, the effect size was regressed on the potential continuous, study-level moderators. If the slope ( $b$ ) of the regression line reached the  $p = .05$  level of significance, the variable was considered a moderator of the relationship between discrete emotion and the outcome variables.

The relationships among changes in different outcome measures were examined in order to determine if changes across outcomes co-occurred. To conduct this analysis, we identified articles that contained more than one outcome measure for a comparison (number of studies = 415; it was not required that a study included all outcomes but only that it included at least two different outcomes). The data were transformed to long format in SPSS, such that each row represented a study and the effect sizes associated with different outcomes were in separate columns. To account for potential dependency, we used the effect sizes from the CMA program calculated during analyses of effects for each outcome for each study; thus, these effect sizes were weighted and took into account the dependency of effect sizes. Pearson's correlation coefficients were then calculated between the effect sizes associated with each outcome and effect sizes of other outcomes to assess the extent to which changes in the outcomes co-occurred.

## Results

Results are presented in six sections. First, descriptive analyses of general study characteristics are reported. Second, overall differences among discrete emotions are considered. Third, the association between discrete emotions and changes in cognitive, experiential, behavioral, and physiological outcomes is assessed, with separate effect sizes used for each outcome. Fourth, the practical issue of the effect sizes associated with different types of emotion elicitation is examined by using type of elicitation as a moderator. Fifth, characteristics of the sample and study methodological characteristics are examined as potential moderators of the association between discrete emotions and outcomes. Last, the potential influence of publication bias is considered.

### Descriptive Analyses

Analyses included 510 articles, 687 studies, 4,946 effect sizes, and 49,473 participants. Table 1 presents a summary of the study characteristics. As shown, participants tended to be young college students from the United States. Study samples on average included more than 50% women. It should be noted, however, that effect sizes were frequently based on multiple studies that included no women ( $k = 257$ ; 6.2%) or no men ( $k = 590$ ; 11.9%), because, the authors argued, some elicitation have been shown to be more effective with men or women and it was therefore appropriate to select participants on the basis of gender. A cover story for the emotion elicitation was present in over a third of the studies. Few of the comparisons were from studies that excluded participants on the basis of their reactions to the emotion elicitation. Less than half of the comparisons were from studies where participants were in a group rather than alone and more than half were from studies that utilized a between-subject designs versus a within-subject design.

As reported in Table 1, the largest number of emotion comparisons occurred for happiness versus sadness, followed by happiness or sadness versus neutral conditions. Many of the studies included self-reported experiential reactions. Film elicitation were the most common method of emotion elicitation, followed by imagination, autobiographical recall, and real-life experiences.

### Overall Effect Size

The overall effect size associated with comparisons among discrete emotions was  $g = 0.51$ , 95% CI [0.48, 0.54],  $z = 34.41$ ,  $p < .001$ . Thus, discrete emotions, on average, differed in the effect they had on outcomes, and this effect would be considered to be of medium size. There was significant heterogeneity among these effect sizes,  $Q(686) = 10,748.82$ ,  $p < .001$ , suggesting that moderators might account for some of the variance in the effects. An outlier was identified with effect size values far greater than other studies (Gross & Levenson, 1995), and this study was removed from all analyses because of its significant impact on effect size calculations and comparisons (if included, the average effect size for film clips is  $g = 1.07$ ).

Two additional composite effect sizes were calculated based on whether emotion conditions were compared with neutral conditions or with other emotion conditions. These effect size calculations were conducted at the level of the study and the analyses selected for the relevant contrasts within each study, resulting in

Table 1  
*Summary of Study Characteristics and Associated Effect Size Statistics*

Characteristic	No. of studies	<i>M</i> or % (or % of studies)	Effect size ( <i>g</i> )	95% CI
Overall effect size	687		0.51 <sup>***</sup>	[0.48, 0.54]
Participant characteristics				
Mean age	259	26.35		
% female	539	59.76		
From U.S.	687	65%		
College students	687	87%		
Methodological characteristics				
Cover story	687			
Present		43%	0.44 <sup>***</sup>	[0.44, 0.48]
Absent			0.56 <sup>***</sup>	[0.52, 0.61]
Excluded participants	687			
Excluded		12%	0.47 <sup>***</sup>	[0.39, 0.54]
Did not exclude			0.51 <sup>***</sup>	[0.48, 0.55]
Group vs. alone	687			
Group		27%	0.46 <sup>***</sup>	[0.41, 0.51]
Alone			0.53 <sup>***</sup>	[0.49, 0.56]
Between- vs. within-subject	687			
Between-subjects		75%	0.48 <sup>***</sup>	[0.45, 0.51]
Within-subject			0.59 <sup>***</sup>	[0.53, 0.66]
Emotion comparisons				
Happiness vs. sadness	346	50%	0.68 <sup>***</sup>	[0.62, 0.74]
Happiness vs. anger	59	9%	0.70 <sup>***</sup>	[0.56, 0.85]
Happiness vs. anxiety	49	7%	0.96 <sup>***</sup>	[0.76, 1.16]
Happiness vs. neutral	229	33%	0.41 <sup>***</sup>	[0.36, 0.46]
Sadness vs. anger	63	9%	0.27 <sup>***</sup>	[0.19, 0.35]
Sadness vs. anxiety	51	7%	0.26 <sup>***</sup>	[0.18, 0.35]
Sadness vs. neutral	263	38%	0.41 <sup>***</sup>	[0.36, 0.46]
Anger vs. anxiety	52	8%	0.13 <sup>***</sup>	[0.07, 0.19]
Anger vs. neutral	104	15%	0.51 <sup>***</sup>	[0.43, 0.60]
Anxiety vs. neutral	113	16%	0.55 <sup>***</sup>	[0.45, 0.64]
Outcomes				
Cognitive	166	24%	0.24 <sup>***</sup>	[0.18, 0.30]
Judgment	234	34%	0.26 <sup>***</sup>	[0.22, 0.30]
Self-report experiential	573	83%	0.83 <sup>***</sup>	[0.79, 0.88]
Behavioral	156	23%	0.31 <sup>***</sup>	[0.25, 0.38]
Physiological	109	16%	0.31 <sup>***</sup>	[0.24, 0.38]
Elicitations				
Film	162	24%	0.60 <sup>***</sup>	[0.53, 0.66]
Pictures	25	4%	0.81 <sup>***</sup>	[0.58, 1.03]
Priming	12	2%	0.26 <sup>*</sup>	[0.02, 0.49]
Music	49	7%	0.53 <sup>***</sup>	[0.41, 0.65]
Velten	93	14%	0.51 <sup>***</sup>	[0.44, 0.58]
Imagination	73	11%	0.51 <sup>***</sup>	[0.42, 0.61]
Reading text	19	3%	0.41 <sup>***</sup>	[0.29, 0.53]
Behavioral	24	3%	0.47 <sup>***</sup>	[0.34, 0.60]
Real-life experiences	105	15%	0.46 <sup>***</sup>	[0.37, 0.54]
Autobiographical recall	136	20%	0.45 <sup>***</sup>	[0.39, 0.51]

*Note.* Effect sizes are Hedges' *g*, with .2 considered small, .5 considered medium, and .8 considered large. Numbers in brackets are 95% confidence intervals for the effect size. Significance values are associated with the *z* statistic.

\*  $p < .05$ . \*\*\*  $p < .001$ .

effect sizes based only on the relevant contrasts. The overall effect size associated with comparisons between discrete emotions and neutral conditions was  $g = 0.46$  (460 studies; 95% CI [0.43, 0.49]),  $z = 26.41$ ,  $p < .001$ ,  $Q(459) = 4,649.32$ ,  $p < .001$ . This indicates that, on average, discrete emotions had different effects on outcomes than neutral conditions did. The overall effect size associated with comparisons among discrete emotions (excluding contrasts of emotions with neutral conditions) was  $g = 0.58$  (443 studies; 95% CI [0.54, 0.62]),  $z = 27.05$ ,  $p < .001$ ,  $Q(442) = 8,061.25$ ,  $p < .001$ . This indicates that, on average, discrete

emotions had different effects on outcomes than other discrete emotions did. Thus, effect sizes were medium-sized for emotions versus neutral conditions and for emotions compared with other emotions.

### Major Theories of Emotion

**Effect sizes associated with different outcomes.** Is there evidence that supports the proposition that there are discrete emotions that elicit changes across cognitive, experiential, behavioral,

and physiological outcomes? As already reported, the overall effect sizes were of medium size, suggesting that there was evidence consistent with the proposition that discrete emotions have unique effects on outcomes, overall. Effect sizes also differed by the type of outcome,  $Q_B(4) = 66.40, p < .001$ . The effect sizes for each outcome are reported in Table 1. All effects significantly differed from zero, suggesting that emotions influenced all outcomes. Self-reported experiential outcomes were associated with a large effect size, which was larger than the small- to medium-sized effects associated with cognitive,  $Q_B(1) = 101.60, p < .001$ ; judgment,  $Q_B(1) = 95.71, p < .001$ ; behavioral,  $Q_B(1) = 45.32, p < .001$ ; and physiological outcomes,  $Q_B(1) = 127.72, p < .001$ .

#### Effect sizes associated with different emotion comparisons.

Type of emotion was a significant moderator of the association between discrete emotions and the outcomes,  $Q_B(9) = 114.28, p < .001$ . The effect sizes associated with each emotion comparison are reported in Table 1. The effect sizes associated with comparisons of the influence of happiness versus negative emotions (sadness, anger, and anxiety) were of moderate to large size. Effect sizes associated with comparisons of the influence of any emotion (happiness, sadness, anger, and anxiety) versus neutral conditions were of moderate size. The effect sizes associated with comparisons of the influence of sadness and other negative emotions (anger, anxiety) were of small to moderate size. The effect size associated with comparison of the influence of anger versus anxiety was quite small, although it significantly differed from zero. Specific predictions regarding the differences in effect sizes between discrete emotion comparisons based on several major theoretical models of emotion are considered in turn below.

**Correlated changes across outcomes.** To examine whether changes in cognition, behavior, experience, and physiology co-occurred, we identified studies that included more than one outcome for an emotion comparison (details for this analysis are presented in the Method section). As reported in Table 2, changes in self-reported experience were significantly correlated with changes in behavior and changes in physiology; changes in physiology were significantly correlated with changes in cognition, changes in behavior, and changes in self-reported experience. Changes in cognition and changes in judgment did not significantly correlate with one another or with changes in other outcomes, with the exception of cognition and physiology. Some correlations were of small to medium size but were nonsignificant (i.e., the relationship

between judgment and physiology), potentially due to sample size restrictions. This finding suggests that at least some components of emotion do covary in response to the elicitation of discrete emotions.

**Valence models.** Valence models of emotion suggest that effect sizes should be large between positive and negative emotions and that effect sizes for comparisons among negative emotions should be small, indicating that they have similar effects on outcomes. To examine this possibility, we coded comparisons as occurring between positive and negative emotion or between negative emotions and conducted an analysis to examine whether type of comparison accounted for variance in the effects. The effect sizes were indeed larger for comparisons of the influence of happiness versus negative emotions,  $g = 0.67, 95\% \text{ CI } [0.61, 0.72], z = 22.87, p < .001$ , than for comparisons of the influence of negative emotions versus other negative emotions,  $g = 0.28, 95\% \text{ CI } [0.21, 0.35], z = 7.76, p < .001, Q_B(1) = 75.53, p < .001$ . (See Table 1 for specific comparisons; note that this analysis did not include comparisons to neutral conditions.) However, the effect size associated with comparisons among negative emotions was of small to moderate size and significantly differed from zero, suggesting that valence could not completely account for the pattern of results.

Some descriptions of valence models suggest that observed differences among discrete emotions are the result of preconceptions about emotions (i.e., that people experience sadness as different from anger because they have learned to do so). This issue could not be directly addressed, but, if true, effect sizes should be larger for self-reported experiential outcomes relative to effect sizes for other outcomes. As shown in Table 3, effect sizes associated with self-reported experience were moderate to large and the effect sizes for experience were frequently the largest effect relative to effects associated with all other outcomes. Effect sizes associated with outcomes other than self-reported experience were mostly small for contrasts between sadness and anger and anger and anxiety. It is worth noting that the comparisons between anxiety versus neutral conditions and anger versus neutral conditions were mostly of moderate size for non-self-report outcomes. This suggests that the small effect sizes associated with comparisons of anger to anxiety or neutral conditions were not due to a general failure to elicit anger or anxiety. Thus, there was support for the argument that differences among discrete negative emo-

Table 2  
Correlation Coefficients (With Degrees of Freedom) Between Effect Sizes for Different Outcome Measures Within Studies

Variable	1	2	3	4	5
1. Cognition	—	.19 (58)	-.01 (66)	-.01 (253)	.40 (35)*
2. Judgment		—	.14 (63)	.08 (292)	.27 (25)
3. Behavior			—	.59 (216)***	.28 (54)*
4. Experience				—	.41 (145)***
5. Physiology					—

*Note.* To calculate these coefficients, we calculated a combined effect size for each outcome in each study that included more than one outcome. Correlations were then calculated among those effect sizes. Note that some small to moderate correlations (i.e., the relationship between changes in judgment and changes in physiology) are not significant, likely due to small sample size.

\*  $p < .05$ . \*\*\*  $p < .001$ .

Table 3  
*Effect Sizes for Type of Outcome for Each Emotion Comparison*

Emotion comparison	No. of studies	Effect size (g)	95% CI
<b>Happiness vs. sadness</b>			
Cognition	90	0.30***	[0.21, 0.40]
Judgment	113	0.28***	[0.22, 0.35]
Experience	297	1.16***	[1.06, 1.26]
Behavior	76	0.51***	[0.37, 0.65]
Physiology	34	0.15	[-0.10, 0.39]
<b>Happiness vs. anger</b>			
Cognition	8	0.24 <sup>†</sup>	[-0.04, 0.72]
Judgment	19	0.34*	[0.08, 0.59]
Experience	43	0.95***	[0.73, 1.18]
Behavior	10	0.46	[-0.19, 1.10]
Physiology	14	0.89***	[0.45, 1.34]
<b>Happiness vs. anxiety</b>			
Cognition	8	0.53*	[0.02, 1.05]
Judgment	8	0.39 <sup>†</sup>	[-0.04, 0.81]
Experience	35	1.61***	[1.29, 1.92]
Behavior	6	1.61**	[0.42, 2.80]
Physiology	19	0.40***	[0.20, 0.61]
<b>Happiness vs. neutral</b>			
Cognition	62	0.28***	[0.18, 0.38]
Judgment	73	0.21***	[0.13, 0.28]
Experience	194	0.70***	[0.61, 0.78]
Behavior	51	0.28***	[0.16, 0.39]
Physiology	19	0.08	[-0.20, 0.36]
<b>Sadness vs. anger</b>			
Cognition	7	0.12	[-0.14, 0.38]
Judgment	25	0.18**	[0.06, 0.31]
Experience	45	0.38***	[0.25, 0.50]
Behavior	6	-0.18	[-0.73, 0.37]
Physiology	14	0.19	[-0.05, 0.42]
<b>Sadness vs. anxiety</b>			
Cognition	6	0.23	[-0.06, 0.53]
Judgment	10	0.34	[-0.14, 0.82]
Experience	35	0.34***	[0.21, 0.47]
Behavior	4	-0.02	[-0.88, 0.84]
Physiology	20	0.11 <sup>†</sup>	[-0.01, 0.24]
<b>Sadness vs. neutral</b>			
Cognition	72	0.12**	[0.03, 0.22]
Judgment	95	0.26***	[0.19, 0.33]
Experience	225	0.73***	[0.64, 0.82]
Behavior	66	0.15**	[0.05, 0.25]
Physiology	17	-0.01	[-0.15, 0.14]
<b>Anger vs. anxiety</b>			
Cognition	4	0.38*	[0.07, 0.69]
Judgment	15	0.18	[-0.14, 0.18]
Experience	37	0.24***	[0.12, 0.37]
Behavior	5	0.20	[-0.85, 1.24]
Physiology	27	0.06	[-0.05, 0.17]
<b>Anger vs. neutral</b>			
Cognition	18	0.36***	[0.19, 0.53]
Judgment	31	0.36***	[0.20, 0.52]
Experience	76	0.80***	[0.61, 0.98]
Behavior	30	0.46**	[0.18, 0.74]
Physiology	34	0.55***	[0.37, 0.72]
<b>Anxiety vs. neutral</b>			
Cognition	25	0.33***	[0.15, 0.52]
Judgment	27	0.31***	[0.15, 0.46]
Experience	92	1.05***	[0.87, 1.24]
Behavior	15	0.27 <sup>†</sup>	[-0.03, 0.57]
Physiology	41	0.33**	[0.14, 0.52]

*Note.* Effect sizes are Hedges'  $g$ , with .2 considered small, .5 considered medium, and .8 considered large. Some effect sizes are based on a relatively small number of effects and should thus be considered potentially unreliable. Note that some large effect sizes are not significant due to small sample size or variability associated with the effect size. Significance values are associated with the  $z$  statistic.

<sup>†</sup>  $p < .10$ . \*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

tions are greater for outcomes dependent upon conscious awareness than for outcomes less susceptible to conscious biases.

**Valence and arousal models.** Valence and arousal models suggest that anger and anxiety should have similar effects on outcomes. As mentioned, the effect size associated with comparisons between anger and anxiety was small relative to that for other emotion comparisons, although this effect significantly differed from zero (see Table 1). In contrast to predictions derived from a valence and arousal model, however, comparisons between sadness and anxiety for non-self-report outcomes were also quite small; with the exception of cognition, most did not significantly differ from zero. As noted previously, there did not appear to be a general failure to elicit anxiety or anger.

**Approach and avoidance models.** To examine the degree of support for approach and avoidance models, we combined comparisons between emotions of the same motivational direction (i.e., happiness vs. anger, sadness vs. anxiety) and combined comparisons between emotions of different motivational direction (i.e., happiness vs. anxiety, happiness vs. sadness, anger vs. anxiety, anger vs. sadness). An analysis was conducted to examine whether type of comparison accounted for variance in the effects. In contrast to predictions based on approach and avoidance models, there was no significant difference between the effect sizes of comparisons between emotions of the same motivational direction,  $g = 0.58$ , 95% CI [0.38, 0.78],  $z = 5.60$ ,  $p < .001$ , and emotions of different motivational directions,  $g = 0.60$ , 95% CI [0.55, 0.65],  $z = 23.24$ ,  $p < .001$ ,  $Q_B(1) = 3.03$ ,  $p = .22$ . The effect sizes associated with all comparisons on self-report experiential outcomes were greater than zero (see Table 3 for specific effect sizes), but effects on other outcomes varied. Some were quite small and did not differ from zero. As noted, self-reported experience is particularly likely to be influenced by people's beliefs about emotions rather than actual differences in emotion. We therefore repeated the above analysis excluding self-reported outcomes and examining only changes in cognitive, judgment, behavioral, and physiological outcomes. Again, considering only cognitive, judgment, behavioral, and physiological outcomes, there was no significant difference between the effect sizes of comparisons between emotions of the same motivational direction,  $g = 0.43$ , 95% CI [0.16, 0.69],  $z = 3.15$ ,  $p = .002$ , and different motivational direction,  $g = 0.28$ , 95% CI [0.24, 0.33],  $z = 12.40$ ,  $p < .001$ ,  $Q_B(1) = 1.49$ ,  $p = .48$ .

### Major Types of Elicitations and Related Issues

The type of emotion elicitation moderated the relationship between discrete emotions and outcomes,  $Q_B(9) = 26.19$ ,  $p = .003$ . As reported in Table 1, the effect sizes associated with all elicitations differed from zero, and most effects were of moderate size. The effect size associated with priming was smallest, and the effect size associated with picture elicitations was the largest. Table 4 presents the effect sizes associated with specific elicitation techniques for each discrete emotion comparison. Due to the small sample sizes in many cases, specific contrasts were not possible. Films, by far the most frequently used elicitation, were effective for most emotion comparisons, with the exceptions of anger and anxiety and sadness and anger. Some elicitations with large effect sizes were relatively infrequently used, including pictures and real-life experiences.

### Methodological Moderators

A meta-regression analysis using maximum likelihood (described in the Method section) revealed that the average age of participants in the sample did not moderate effect sizes or predict effect size,  $b = .01$ , 95% CI [-.001, -.014],  $z = 1.64$ ,  $Q_R = 2.70$ ,  $p = .10$ . It is possible that restricted range influenced this result, as only 218 out of the nearly 5,000 effect sizes were based on participants with an average age over 40 years.

A similar meta-regression analysis was conducted to examine the influence of gender and the proportion of female participants in a sample did not predict effect size,  $b = -.001$ , 95% CI [-.000, -.003],  $z = 1.58$ ,  $Q_R = 2.49$ ,  $p = .11$ . The social acceptability of discrete emotions differs for men and women, and the relation of gender to effect sizes for emotional comparisons that included anger versus happiness and sadness was therefore examined. Elicitations that included happiness and sadness as comparison groups were more effective as the percentage of women increased,  $b = .002$ , 95% CI [.002, .007],  $z = 3.35$ ,  $Q_R = 11.23$ ,  $p < .001$ , and this was true both for self-report outcomes,  $b = .006$ , 95% CI [.001, .01],  $z = 2.49$ ,  $Q_R = 6.16$ ,  $p = .01$ , and for non-self-report outcomes,  $b = .002$ , 95% CI [.0004, .004],  $z = 2.45$ ,  $Q_R = 6.01$ ,  $p = .01$ . In contrast, the proportion of women in the sample did not predict the effectiveness of elicitations that included anger,  $b = -.001$ , 95% CI [-.003, .001],  $z = -0.86$ ,  $Q_R = 0.74$ ,  $p = .39$ .

Analyses that included categorical moderators were conducted comparing the groups of the moderator (as in the overall analysis, these calculated effect sizes by study to control for dependent effects). As described previously, most of the studies were conducted in the United States, and country of participants did not moderate the effect size model,  $Q_B(1) = 0.02$ ,  $p = .89$ . Whether participants were college students or community members also did not significantly moderate the effect size model,  $Q_B(1) = 0.92$ ,  $p = .34$ .

Means for the effect sizes associated with methodological moderators are shown in Table 1. Effect sizes were significantly smaller in studies that included a cover story to mask the intent of the emotion elicitation from participants than in studies that did not,  $Q_B(1) = 27.78$ ,  $p < .001$ . Whether participants were excluded on the basis of their response to the emotion elicitation did not significantly influence effect sizes,  $Q_B(1) = 1.36$ ,  $p = .25$ ; however, effect sizes tended to be nonsignificantly somewhat smaller for studies that excluded participants than for studies that did not exclude participants. Whether study participants took part as a group or as individuals was a marginal moderator of effect sizes,  $Q_B(1) = 5.38$ ,  $p = .06$ . Effect sizes tended to be larger when participants took part individually rather than in groups. Effect sizes were influenced by whether studies utilized a within- or between-subjects design,  $Q_B(1) = 9.28$ ,  $p = .01$ . Effect sizes from studies that used within-subject comparisons were larger than those from studies that used between-subjects comparisons.

### Evaluation of Publication Bias

A funnel plot, trim-and-fill method, and fail-safe  $n_s$  were examined to evaluate the likelihood that publication bias (the tendency for published studies available for meta-analyses to report significant results) influenced the results of this review. A funnel plot is a scatter plot showing the effect size in relation to sample

Table 4  
*Effect Sizes for Type of Emotion Elicitation for Each Emotion Comparison*

Emotion comparison	No. of studies	Effect size (g)	95% CI
<b>Happiness vs. sadness</b>			
Film	106	0.88***	[0.76, 1.00]
Pictures	15	1.02***	[0.52, 1.53]
Prime	4	-0.07	[-0.31, 0.17]
Music	39	0.66***	[0.49, 0.85]
Velten	48	0.74***	[0.62, 0.86]
Imagine	26	0.72***	[0.47, 0.97]
Read text	7	0.47***	[0.27, 0.66]
Behavior	11	0.48 <sup>†</sup>	[-0.07, 1.02]
Real	19	0.54***	[0.42, 0.66]
Recall	75	0.49***	[0.41, 0.57]
<b>Happiness vs. anger</b>			
Film	14	0.87***	[0.53, 1.22]
Pictures	2	0.17	[-0.39, 0.73]
Prime	1	0.22	[-0.29, 0.72]
Music	2	1.16***	[0.71, 1.62]
Velten	3	0.26 <sup>†</sup>	[-0.02, 0.53]
Imagine	10	0.55***	[0.25, 0.84]
Read text	3	0.25	[-0.36, 0.86]
Behavior	9	1.03***	[0.55, 1.51]
Real	5	0.94***	[0.66, 1.21]
Recall	11	0.59***	[0.27, 0.91]
<b>Happiness vs. anxiety</b>			
Film	15	1.08***	[0.78, 1.40]
Pictures	5	2.04**	[0.78, 3.31]
Prime	2	0.06	[-0.55, 0.67]
Music	6	1.87**	[0.74, 3.00]
Velten	0		
Imagine	9	1.08***	[0.53, 1.63]
Read text	0		
Behavior	7	0.68**	[0.25, 1.12]
Real	1	0.10	[-0.39, 0.59]
Recall	5	0.77***	[0.34, 1.21]
<b>Happiness vs. neutral</b>			
Film	88	0.45***	[0.38, 0.53]
Pictures	8	0.47***	[0.20, 0.73]
Prime	5	-0.05	[-0.26, 0.16]
Music	11	0.30**	[0.13, 0.47]
Velten	34	0.45***	[0.34, 0.56]
Imagine	24	0.48***	[0.33, 0.63]
Read text	7	0.56***	[0.27, 0.86]
Behavior	3	0.37*	[0.07, 0.67]
Real	19	0.36***	[0.20, 0.52]
Recall	31	0.26***	[0.16, 0.35]
<b>Sadness vs. anger</b>			
Film	13	0.16 <sup>†</sup>	[-0.01, 0.33]
Pictures	0		
Prime	0		
Music	2	0.30***	[0.19, 0.41]
Velten	3	0.10	[-0.22, 0.41]
Imagine	8	0.18**	[0.05, 0.32]
Read text	8	0.41***	[0.25, 0.57]
Behavior	9	0.21**	[0.05, 0.38]
Real	3	-0.19	[-0.92, 0.52]
Recall	19	0.36**	[0.14, 0.58]
<b>Sadness vs. anxiety</b>			
Film	14	0.22**	[0.08, 0.35]
Pictures	4	0.43 <sup>†</sup>	[-0.05, 0.90]
Prime	0		
Music	6	0.47	[-0.10, 21.07]
Velten	6	0.23*	[0.01, 0.44]
Imagine	10	0.30**	[0.11, 0.49]
Read text	0		
Behavior	8	0.18 <sup>†</sup>	[-0.01, 0.37]
Real	0		
Recall	6	0.40	[-0.09, 0.89]

(table continues)

Table 4 (continued)

Emotion comparison	No. of studies	Effect size ( <i>g</i> )	95% CI
Sadness vs. neutral			
Film	93	0.50***	[0.40, 0.59]
Pictures	8	0.35***	[0.17, 0.53]
Prime	2	-0.16	[-0.43, 0.11]
Music	15	0.28***	[0.16, 0.41]
Velten	61	0.36***	[0.28, 0.44]
Imagine	27	0.41***	[0.19, 0.63]
Read text	8	0.43***	[0.28, 0.58]
Behavior	2	-0.38	[-0.71, -0.04]
Real	13	0.39***	[0.27, 0.52]
Recall	37	0.37***	[0.23, 0.51]
Anger vs. anxiety			
Film	10	-0.05	[-0.13, 0.03]
Pictures	2	-0.02	[-0.22, 0.19]
Prime	2	0.51***	[0.26, 0.76]
Music	2	0.34	[-0.65, 1.33]
Velten	1	-0.08	[-0.68, 0.51]
Imagine	13	0.24***	[0.11, 0.37]
Read text	1	0.37***	[0.24, 0.50]
Behavior	8	0.12*	[0.06, 0.54]
Real	6	0.03	[0.36, 0.72]
Recall	8	0.05	[-0.11, 0.20]
Anger vs. neutral			
Film	14	0.30**	[0.13, 0.48]
Pictures	2	0.72	[-0.96, 2.40]
Prime	4	0.26†	[-0.04, 0.55]
Music	1	0.18	[-0.06, 0.42]
Velten	1	-0.21	[-0.82, 0.40]
Imagine	19	0.56***	[0.38, 0.74]
Read text	3	0.72*	[0.17, 1.27]
Behavior	3	0.96*	[0.14, 1.78]
Real	35	0.57***	[0.42, 0.72]
Recall	24	0.52***	[0.32, 0.71]
Anxiety vs. neutral			
Film	17	0.51***	[0.30, 0.73]
Pictures	8	1.61***	[0.85, 2.36]
Prime	6	0.56***	[0.26, 0.85]
Music	4	0.31**	[0.12, 0.51]
Velten	5	0.27	[-0.13, 0.67]
Imagine	25	0.64***	[0.37, 0.91]
Read text	2	0.09	[-0.04, 0.22]
Behavior	2	0.42	[-0.74, 1.58]
Real	35	0.47***	[0.32, 0.63]
Recall	12	0.55***	[0.28, 0.82]

Note. Effect sizes are Hedges' *g*, with .2 considered small, .5 considered medium, and .8 considered large. Some effect sizes are based on a relatively small number of effects and should thus be considered potentially unreliable. Note that some medium to large effect sizes are not significant due to small sample size or variability associated with the effect size. Significance values are associated with the *z* statistic.

†  $p < .10$ . \*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

size. It is examined visually for symmetry (asymmetry indicates a potential publication bias because the size of the sample is related to the effect). A funnel plot we constructed appeared asymmetrical, as studies in the bottom half of the plot fell on the right of the mean effect size. This suggested that there was evidence of bias, as smaller studies were associated with larger effect sizes. It is important to note that funnel plots reveal bias, but this bias may reflect actual differences among studies rather than publication bias (Borenstein et al., 2009). These "small-study effects" occur when studies with small samples also tend to use methodologies associated with larger effects (Sterne & Egger, 2001). In the present review, studies that assessed the effects of emotion on physiological outcomes tended to use small samples and tended to

use within-subject designs. Physiological outcomes and within-subject designs were both associated with large effect sizes. Therefore, the asymmetry in the funnel plot may indicate the effects of these physiological studies rather than the effects of publication bias.

In order to assess the potential impact of the missing studies on the overall effect size, we used the Duval and Tweedie (2000) trim-and-fill technique to impute the effect sizes associated with the potential missing studies. The funnel plot with these imputed values is presented in Figure 1. As can be seen, this technique revealed an observed effect size of .37 and an adjusted effect size of .26, suggesting that the missing studies that might result from publication bias would have little impact on the overall effect size

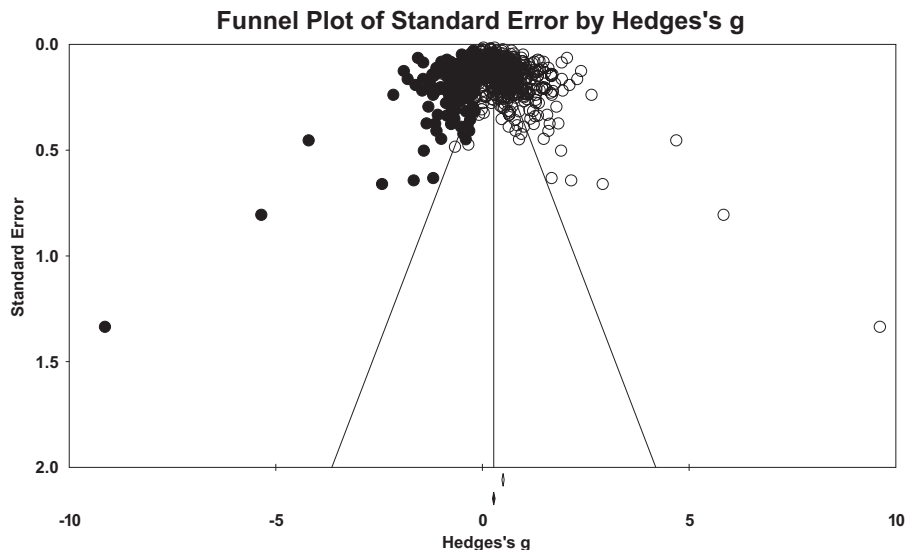


Figure 1. The funnel plot presents the standard error on the y-axis and the Hedges'  $g$  effect size on the x-axis (the bottom half of the plot represents smaller studies). White circles represent observed data points and black circles represent imputed data points from trim-and-fill procedures that take the place of possible studies that may be missing due to publication bias. On the x-axis, the white diamond (top mark) represents the mean effect size without potential publication bias taken into account; the black diamond (bottom mark) represents the mean effect size with the imputed values.

and that the effect was robust. Additional analyses also suggested that the overall effect was robust and was unlikely to be an artifact of publication bias. A classic fail-safe  $n$  calculation suggested that 2,612 studies with nonsignificant findings would have to exist in order for the reported effect to be nonsignificant (Rosenthal, 1991). Orwin's fail-safe  $n$ , a more conservative calculation, indicated that the mean effect size in studies outside the report would have to be .00000 in order for the reported effects to be nonsignificant. We believe that concern over publication bias was further reduced in this particular review, because studies often reported significant effects in the predicted direction for some study variables and not for others and we included all comparisons in this review. For example, a particular elicitation for sadness might result in more self-reported sadness (as predicted) but also more self-reported anger (in contrast to predictions).

## Discussion

The present investigation was intended to synthesize past research in which emotions were elicited as an experimental manipulation. Our purpose in the review was to address whether happiness, sadness, anger, and anxiety were associated with differences in cognition, judgment, experience, behavior, and physiology; whether these changes co-occur; and which factors moderate these effects. A review and research synthesis was conducted of existing studies in order to address these questions. The overall purpose was to provide information about emotion and emotion elicitation that would be of theoretical and practical value.

## Major Theories of Emotion

There is growing agreement that emotions are evolutionarily adaptive responses that serve to organize cognitive, judgment,

experiential, behavioral, and physiological reactions to changes in the environment (e.g., Ekman, 1992; Frijda, 1987; Izard, 1971; Lerner & Keltner, 2001; Mauss et al., 2005; Pinker, 1997; Rottenberg et al., 2007). One of our primary goals in the present review was to evaluate the extent to which the existing research evidence was consistent with this view.

**Discrete emotion models.** Overall, there was a medium effect size across all comparisons among the discrete emotions included in this review. There was also a medium effect size for all emotions compared with neutral conditions and all emotions compared with other emotions. Further, the effect sizes associated with all of the comparisons among discrete emotions were greater than zero, although the effect sizes associated with the comparison between anger and anxiety and anger and neutral conditions were quite small. The small difference between anger and anxiety may be due to an underlying similarity, perhaps on an arousal dimension, as suggested by valence and arousal accounts of emotion. It is also possible, however, that emotion elicitation have not effectively targeted one emotion (e.g., a film segment that shows a bully picking on a child may elicit anger and anxiety). The effect sizes associated with the comparison between discrete emotions and neutral conditions were all significantly greater than zero, suggesting that emotional experiences were indeed elicited in experimental settings. There also was evidence that behavioral, experiential, and physiological responses tended to covary following elicitation of the discrete emotions of happiness, sadness, anger, and anxiety. Cognition and judgment did not correlate with one another or with other changes. Theories of emotion vary in the stress placed on various components of emotion. For example, some theories stress the cognitive and judgment changes that occur with the experience of discrete emotions (e.g., Lerner & Keltner, 2001), whereas other theories stress the co-occurrence of experiential, physiological,

and facial expression behaviors (e.g., Izard, 1971). Theories that stress components essential to emotion (behavior, physiology, and experience) may receive better empirical support than theories that focus on components that are primed by emotion but are not necessarily integral (cognition, judgment). Effects associated with these less integral components may be more likely to be moderated by individual and situational factors.

In general, the findings are consistent with those of studies that have shown changes across systems following emotional experience (Frijda, 1987; Lench & Levine, 2005; Lerner & Keltner, 2001; Mauss et al., 2005). There were differences, however, in the effect sizes associated with different comparisons among discrete emotions, and these differences may be informative about the extent to which the existing evidence is consistent with different theories of emotion. It is important to remember when evaluating these findings that the inferences are limited by the fact that some proposed discrete emotions were not represented in this review (e.g., pride, disgust) and that we examined only studies that elicited discrete emotions and did not include studies that manipulated valence or arousal only. It is possible that some emotion models might be more clearly supported with emotions other than those examined in this review or in studies whose manipulations are based on those models. And, of course, the ability to draw inferences from a pattern of findings in the literature is limited by the methodological rigor of the studies included in the review.

**Valence models.** Valence and valence plus arousal have been posited to capture important aspects of emotional experience (e.g., Barrett, 1998; Russell, 1980). Effect sizes associated with comparisons that contrasted happiness and negative emotions were indeed larger than effect sizes associated with comparisons among negative emotions, as would be predicted from valence models. However, the effect size associated with the latter comparisons was greater than zero and would be considered small in size. This finding suggests that there are small but consistent differences in the effects of the discrete negative emotions of sadness, anger, and anxiety that cannot be captured by valence models.

**Valence and arousal models.** Most models describe anger and anxiety as similar in terms of valence (negative) and arousal (high), and this comparison was therefore examined for evidence of the importance of valence and arousal (Feldman-Barrett & Russell, 1998; Larsen & Diener, 1992; Russell, 1980; Watson & Tellegen, 1985). In the present review, the effect size associated with the comparison between anger and anxiety was indeed a small effect size relative to those for other emotion comparisons. These findings suggest that a valence and arousal model captures important information about the differences among emotions. But the effect size associated with the comparison between sadness and anxiety was also small, and this relatively small effect cannot be accounted for in valence and arousal models that consider sadness a low-arousal emotion and anxiety a high-arousal emotion. Thus, there was evidence that valence and arousal capture important information about the differences among emotions, but there remained differences in outcomes among discrete emotions that could not be explained by these models. A portion of this difference was captured by including whether outcomes were self-reported or not, but some of the findings remained inconsistent with a valence and arousal model even after the type of outcome was considered. It is important to remember in evaluating this evidence that the review included only studies that attempted to

elicit discrete emotions. Thus, it cannot be informative about the effect sizes associated with elicitation of general positive or negative states.

Some theorists who support a valence or valence/arousal model of emotion have suggested that differences in discrete emotions result from culturally developed expectations or beliefs about emotion (e.g., Barrett & Russell, 1999). In the present investigation, the effect sizes associated with comparisons among all emotions were consistently greater than zero only for self-reported experiences. For measures other than self-report, the effect sizes that compared anxiety and anger, sadness and anger, and sadness and anxiety were small. Although this finding does not clearly support a valence model, it does suggest that differences among discrete emotions of the same valence may be—particularly for negative emotions compared with anxiety—the result of beliefs about emotions. This possibility remains to be directly tested. Anxiety is notoriously difficult to elicit through standard emotion elicitation (e.g., Gross & Levenson, 1995), but this difficulty cannot explain why anxiety elicitation would effectively elicit changes in self-reported outcomes relative to other negative emotions but not other outcomes. Nor can it explain the finding that the effect size associated with anxiety compared with neutral groups was greater than zero for self-report and for other outcomes. Thus, there was no evidence that anxiety influenced outcomes other than self-report in ways that differed from other negative emotions.

**Approach and avoidance models.** Other theories of emotion stress the degree to which emotions are associated with approach or avoidance motivations (Bechara et al., 1997; Carver, 2004; Gray, 1972). Approach and avoidance models that describe positive emotions as approach emotions and negative emotions as avoidance emotions are supported by the same evidence described above for valence models. Other models suggest that happiness and anger are approach emotions and sadness and anxiety are avoidance emotions (Bodenhausen et al., 1994; Harmon-Jones, 2003; Henriques & Davidson, 1991). The effect sizes associated with emotions of different motivational directions were no greater than those associated with emotions of the same motivational direction, which is inconsistent with an approach and avoidance model. When only outcomes that did not rely on self-report were examined, the findings offered mixed support for an approach and avoidance model. Multiple comparisons were consistent with predictions from these models, and other comparisons were inconsistent with predictions.

## Major Types of Elicitations and Related Issues

The present meta-analysis was also designed to answer practical questions about the effectiveness of experimental emotion elicitation. Researchers often have little or no guidance about the type of elicitation method to select and methodological issues that may impact its efficacy. The majority of elicitation appeared to elicit the target emotions to a greater extent than neutral conditions or other nontarget emotions. Velten-type elicitation have been shown to effectively elicit general positive and negative states (Gerrards-Hesse et al., 1994; Westermann et al., 1996); however, these elicitation were not especially effective elicitors of discrete emotions in the present review. There was no evidence that personally experienced elicitation, such as real-life experiences or recalled experiences, resulted in larger effect sizes than did those

that were not personally experienced, such as imagined scenarios or reading text. Indeed, the presentation of pictures appeared to be a particularly effective elicitor of discrete emotions, although it was infrequently used. Film was the most common method of emotion elicitation, and it appeared just as effective as other elicitation techniques for most emotion comparisons. Several elicitations were associated with large effect sizes but were infrequently used, including pictures and real-life experiences. These may be useful elicitations in future research, particularly for emotional states that have proven difficult to elicit in an experimental context (e.g., anger and anxiety).

### Potential Methodological Moderators

There was no evidence that age influenced the degree of differences among discrete emotions (e.g., Carstensen et al., 2003; Charles & Carstensen, 2008); however, most participants were young. A clear test of the proposition that age influences the intensity of discrete emotional experiences would require additional studies that include older participants. Elicitations of happiness and sadness were more effective as the percentage of women in the sample increased, and this was true for self-reported experiential outcomes and other outcomes; elicitations of anger and anxiety were not related to the proportion of women in the sample. This finding suggests that gender may influence the intensity of some discrete emotional experiences, consistent with arguments that the acceptability of emotional experiences or adapted physiology for men or women may dictate how people interpret and react to situations (e.g., Cox et al., 1999; Lench, 2006). Culture and college student savvy have been proposed as potential moderators of the intensity of discrete emotional experiences (e.g., Sears, 1986; Tsai et al., 2006), but there was no evidence of these effects in the present review. This is consistent with the view that emotional experiences are universal; however, most participants were U.S. college students, and lack of variability might have been responsible for the null findings. Further, culture was only very roughly approximated by comparing studies in the United States to those in all other countries, and a more nuanced approach might reveal cultural differences. It is also important to note that few studies included information about the ethnic composition of the sample, and this potential moderator could not be included in the review. This information is critical for future studies on discrete emotions and may help reveal cultural differences in emotional reactions. The gender differences coupled with lack of cultural differences might suggest that only individual characteristics with a strong biological basis, such as gender, may influence emotional reactions. However, more work is needed that includes measures related to culture or participants from various cultures before such a conclusion can be drawn (Henrich, Heine, & Norenzayan, 2010).

About half of the studies incorporated a cover story to mitigate the demand characteristics inherent in emotion elicitations. This is potentially problematic because studies that included a cover story had significantly smaller effect sizes than studies that did not include a cover story, suggesting that a substantial portion of effects of discrete emotions may be due to demand characteristics in the studies. To the extent that researchers are interested in capturing the effects of emotions rather than participants' beliefs about the effects of emotions, it is likely important to include a

cover story. Whether participants were excluded on the basis of their response to the emotion elicitation also tended to moderate the effectiveness of elicitations. Effect sizes tended to be smaller in studies that excluded participants than in those that did not exclude participants. It is possible that the exclusion of some participants may have been sufficient to result in a marginal significance value reaching the traditional cutoff for significance tests ( $p < .05$ ). In order to identify effective techniques and the effects of emotion, studies should include all participants in analyses, regardless of whether they appeared to be impacted by the elicitation. Emotion elicitations tended to be more effective when participants took part as individuals (i.e., alone in a room or separated by cubicle walls) rather than in groups. This suggests that there may be some diffusion of emotional intensity that occurs during group elicitations, possibly because participants are distracting or comforting themselves by attending to other people.

### Portrait of an Effective Discrete Emotion Elicitation

What does an effective emotion elicitation look like? It uses films, pictures, music, or imagination to elicit emotion. The choice among these effective elicitations must be made based on the theoretical interests of the researcher and practical constraints (the References and online supplemental materials identify studies in which the various types of emotion elicitations were used). Films, pictures, and imagined events are likely to prime specific cognitive content, and researchers interested in the effects of emotion independent of cognitive content may want to avoid these elicitations. Behavior, real-life events, and recalled events also prime cognitive content, but if participants are randomly assigned to conditions one can assume that specific cognitive content should be distributed among conditions and should not constitute a threat to validity. Whether standardization within or between conditions is most important should also be considered when choosing an elicitation. It is relatively easy to standardize the presentation and content of films, pictures, and music within a condition, as the researcher can control how the stimuli are viewed, how long they are viewed, the specific images, and surrounding circumstances (Kring & Gordon, 1998; Rottenberg et al., 2007). In addition, there are standardized sets of these elicitations that are available to researchers. It is difficult to standardize across these conditions, however, as the stimuli typically vary on multiple dimensions, including the social aspects of the images, instruments included in music, and the color of images, all of which may influence emotional reactions. In contrast, it is relatively easy to standardize behavior and real-life event elicitations across conditions in the sense that the same event can be enacted with only one crucial difference designed to elicit the target emotion. But these elicitations are difficult to standardize within conditions because of experimenter and participant variability.

The discrete emotions of interest and practical constraints may also determine researchers' choice of elicitations. Previous research has suggested that anxiety may be particularly difficult to elicit in a laboratory setting (e.g., Gross & Levenson, 1995; Larsen & Ketelaar, 1991). It is possible that this difficulty is in part due to the fact that many elicitations require the suspension of disbelief and participants' willing engagement with stimuli (e.g., films, pictures, music, behavior). Real-life experiences may be more useful in eliciting anxiety, and there is evidence that these elicitations

tions elicit a large physiological stress response (for a review, see Dickerson & Kemeny, 2004). Some elicitations may also be impossible due to practical constraints. For example, structuring real-life experiences often requires multiple experimenters and confederates, and this may not be possible without teams of research assistants.

Methodological choices should also be governed by theoretical interests and practical constraints. The gender makeup of the sample must also be determined by practical constraints and by the interests of the researcher, but it should be borne in mind that some emotions will be more effectively elicited depending on the gender composition of the sample. In studies focused on general and theoretically universal constructs or relationships, it would be critical to include men and women and to assess for gender differences. Additional research related to the reasons for gender differences in reactions to emotion elicitations would also be informative about the nature of emotions and their relation to cultural expectations and beliefs.

Although the inclusion of a cover story was associated with smaller effect sizes, it is important in most cases that studies include a cover story. Without a cover it is impossible to determine if any effects are the result of emotions or of demand effects related to participants' beliefs about emotions and beliefs about the experimenter's expectations. The majority of researchers are interested in the effects of emotions on outcomes. Therefore, the inclusion of a cover story is critical, as is avoiding explicit demand statements that participants should simulate emotions.

To heighten the efficacy of elicitations, participants should be in separate rooms or at least separated by cubicle walls. Group elicitations are more efficient in the sense that data can be collected relatively quickly from large groups of participants; however, there appears to be a cost in terms of the associated effect for group elicitations. The effectiveness of some elicitations that might work quite well individually may be reduced in groups, and this may lead researchers to conclude that the manipulation was ineffective.

### Limitations and Recommendations for Future Studies

This review is based on reported studies that included almost 5,000 effect sizes and nearly 50,000 participants, yet some of the comparisons were based on relatively few available effect sizes. In some cases this limited the ability to draw conclusions, particularly in reference to the effectiveness of priming elicitations and the influence of age, culture, and college student status on experimental emotion elicitations. More studies are required that include these variables with diverse samples in order to broaden inferences about the effectiveness of elicitations. Relative to happiness and sadness, anger and anxiety were included in few studies. The present review suggests that these emotions have separable effects on at least some outcomes and that additional studies that elicit multiple discrete emotions are required in order to fully understand the implications of discrete emotions for processing and behavior. Further, as very few studies included multiple discrete positive emotions, they could not be included in the review. Additional work is needed in order to determine if discrete positive emotions have differing effects. Nearly half of the effect sizes were for self-reported emotional reactions. Although self-reports provide important information about emotional experience, theory suggests

that discrete emotions should influence cognition, behavior, and physiology. Research that includes multiple outcomes will test this proposal. Additional research is also needed about how quickly emotions fade after an experience. This information is of practical importance for researchers designing studies on the effects of emotions and is of theoretical importance, given that emotions are defined as relatively brief and intense experiences following an event. An attempt was made in the present review to code the time between emotion elicitation and measurements, but few studies provided this information. It is worth noting that many unusually large effect sizes (though not statistical outliers) were associated with physiological outcomes. Recent critiques have suggested that some physiological measures, particularly electrophysiology and neuroimaging, may have increased potential for Type I error (Kriegeskorte, Simmons, Bellgowan, & Baker, 2009; Vul, Harris, Winkelman, & Pashler, 2009). A similar issue may exist in methodologies that assess changes in autonomic nervous system activity. The cause of this concern is the practice of selectively analyzing a subset of data based on researcher identification of relevant data points; with autonomic nervous system data, this includes identifying time periods to be analyzed and removing perceived artifact data points (Kriegeskorte et al., 2009; Mendes, 2009).

Our conclusions in this review are also limited by the exclusion criteria we used to identify relevant studies. Studies that attempted to elicit discrete emotions were included, and studies that examined moods or general positive and negative states were not included. Therefore, the inferences that can be made are relevant only to discrete emotions. If this review had included studies that manipulated emotional states in a manner consistent with valence or approach/avoidance models, this may have increased the empirical support garnered for these models, because the published results would be more likely to be consistent with such models. The question addressed by this review was not the degree of support for these models but rather the degree to which evidence related to discrete emotions was congruent with predictions derived from these models.

### Conclusions

The study of emotion has taken a prominent place in several psychological theories, and the present review suggests that placement is well deserved, as emotions change the way people think, feel, and behave. Our intent in this review was to examine evidence for discrete emotions and to provide practical information on effective emotion elicitations. Although there are definitely gaps in our knowledge regarding ways to classify emotional responses and reliably elicit responses in an experimental context, this review addresses some of the fundamental questions by examining numerous studies conducted by researchers across areas. In order for the study of emotion to continue to thrive, it is critical that researchers arrive at some agreement regarding what emotion is and what it does.

### References

References with an asterisk were included in the meta-analysis synthesis and are discussed in the text. These references are accompanied by superscripts following the asterisk to indicate the type (or types) of emotion

- elicitation used in that article (B = behavior, D = read text, F = film, I = imagine, L = recall, M = music, P = pictures, Pr = prime, R = real life, V = Velten). For a complete list, go to <http://dx.doi.org/10.1037/a0024244.supp>
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