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The Coherence Effect: Blending Cold and Hot Cognitions

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Abstract

Previous research has shown that making complex judgments and decisions entails a mental reconstruction of the task in a way that increases the state of coherence between the emerging conclusion and its underlying attributes: The attributes that support the conclusion grow stronger, whereas the attributes that support the losing option weaken. This coherence effect is understood to occur bidirectionally, in that conclusions follow from the decision-maker's evaluation of the attributes, while the evaluations of the attributes shift to cohere with the emerging conclusion. The current studies were designed to extend the coherence effect to encompass cognitions that could be considered "hot," such as valence evaluations, motivation toward outcomes of events, liking and disliking of actors, and emotions toward actors. Study 1 found that evaluations of a complex social relationship were accompanied not only by supportive interpretations of the ambiguous facts, but also by concordant hot cognitions. Studies 2 through 4 included manipulations to demonstrate the spreading of coherence from cold to hot cognitions and in the opposite direction. We observed these effects following a manipulation of the facts (Study 2), a manipulation of participants' emotions toward the actor (Study 3), and a manipulation of participants' motivation toward the outcome of the case (Study 4). These results support the proposition that complex judgments and decisions are performed by coherence-based reasoning: a holistic, connectionist process that maximizes coherence among and between the myriad of factors involved in the tasks and the hot cognitive reactions to them.

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Previous research has shown that making complex judgments and decisions entails a mental reconstruction of the task in a way that increases the state of coherence between the emerging conclusion and its underlying attributes: The attributes that support the conclusion grow stronger, whereas the attributes that support the losing option weaken. This *coherence effect* is understood to occur bidirectionally, in that conclusions follow from the decision-maker's evaluation of the attributes, while the evaluations of the attributes shift to cohere with the emerging conclusion. The current studies were designed to extend the coherence effect to encompass cognitions that could be considered "hot," such as valence evaluations, motivation toward outcomes of events, liking and disliking of actors, and emotions toward actors. Study 1 found that evaluations of a complex social relationship were accompanied not only by supportive interpretations of the ambiguous facts, but also by concordant hot cognitions. Studies 2 through 4 included manipulations to demonstrate the spreading of coherence from cold to hot cognitions and in the opposite direction. We observed these effects following a manipulation of the facts (Study 2), a manipulation of participants' emotions toward the actor (Study 3), and a manipulation of participants' motivation toward the outcome of the case (Study 4). These results support the proposition that complex judgments and decisions are performed by coherence-based reasoning: a holistic, connectionist process that maximizes coherence among and between the myriad of factors involved in the tasks and the hot cognitive reactions to them.

Keywords: cognitive consistency theories, the coherence effect, coherence-based reasoning, hot cognitions, parallel constraint satisfaction processing

Previous studies have shown that making judgments and decisions in complex tasks can be understood as driven by a coherence maximizing process. Over the course of reaching a conclusion, the initial states of conflict, contradiction, or ambiguity transform into coherent mental states, wherein the variables that support the emerging conclusion become stronger and the variables associated with the rejected conclusion wane. This spreading apart of the task variables into a subset of strong variables and a subset of weak ones results in confident judgments and decisions. This *coherence effect* has been shown in a variety of tasks, including legal decisions (Holyoak & Simon, 1999; D. Simon, Pham, Le, & Holyoak, 2001), factual inquiries (Glöckner, 2007; D. Simon, Snow, & Read, 2004), choosing between job offers (D. Simon, Krawczyk, Bleicher, & Holyoak, 2008; D. Simon, Krawczyk, & Holyoak, 2004), probabilistic judgments (Glöckner, Betsch, & Schindler, 2010), and financial auditing (Lundberg, 2004, 2007; Phillips, 2002). The coherence effect is closely related to the research on information distortion in decision making (DeKay, Miller, Schley, & Erford, 2014; DeKay, Stone & Sorenson, 2012; Russo, Carlson, Meloy & Yong, 2008; Russo, Meloy & Medvec, 1998).

Coherence-Based Reasoning

The coherence effect is best understood as the product of *coherence-based reasoning*, which is grounded in the family of cognitive consistency theories that flourished in the middle of the 20th century. These theories are comprised notably of Fritz Heider's (1946, 1958) seminal balance theory, and a number of neobalance theories (e.g., Abelson & Rosenberg, 1958; Cartwright & Harary, 1956; Newcomb, 1953; Osgood & Tannenbaum, 1955; Rosenberg, 1960), as well as of cognitive dissonance theory (Festinger, 1957, 1964) and its progeny (Aronson, 1968; Brehm & Cohen, 1962; Wicklund & Brehm, 1976; for a review, see Harmon-Jones & Mills, 1999).

At the heart of cognitive consistency theories lies the Gestaltian tenet that human cognition is substantially affected by mutual interaction among the constituent elements of the cognitive representation (Asch, 1946; Wertheimer, 1922), which is captured by the framework of structural dynamics (Markus & Zajonc, 1985; Zajonc, 1968). The structural nature of the theories was encapsulated in the notion that cognitive states are determined holistically, rather than elementally. As Heider explained, "The properties of these configurations which determine their meaning and their fate

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are whole-qualities. Consonance or simplicity of the structure cannot be derived in an additive way from the properties of the parts" (Heider, 1960, p. 168; see also Festinger, 1957, p. 279). The interrelatedness of the constitutive elements generates forces that determine the configuration of the structure. Structures are bound by cohesive forces that equilibrate at states called *Prägnanz* (Wertheimer, 1923), "good figure" (Heider, 1960; see Markus & Zajonc, 1985), optimum order (Rosenberg & Abelson, 1960), consonance (Festinger, 1957), or equilibrium (Rosenberg & Abelson, 1960; Tannenbaum, 1968). In these stable structures, elements that *go together* also tend to *fit together* in that "all parts of a unit have the same dynamic character (i.e., all are positive, or all are negative), and entities with different dynamic character are segregated from each other" (Heider, 1946, p. 107). States of disequilibrium generate configural forces that operate to restore internal coherence (Heider, 1958; see also Insko, 2012). This homeostatic property (Rosenberg, 1968) is achieved through alterations or "reconstructions" (Rosenberg & Abelson, 1960) of the cognitive elements (Abelson & Rosenberg, 1958; Asch, 1940; Festinger, 1957). This aspect of cognitive alteration is of crucial importance to the coherence effect: Performing complex mental tasks entails forming a judgment from the multiple attributes of the task, but it also entails reverse effects, by which the structural forces impose changes on the individual attributes to bring them into a state of equilibrium with the judgment. Hence, the dynamic character of cognitive consistency theories can be characterized as operating in a bidirectional and recursive manner—from the constitutive attributes toward a conclusion and from the emerging conclusion back to the individual attributes (Read & Simon, 2012; Read, Vanman, & Miller, 1997; D. Simon & Holyoak, 2002).

After having lost much of their appeal during the cognitive revolution (Abelson, 1983), cognitive consistency theories received a breath of life from the advent of connectionist models of constraint satisfaction processing (McClelland & Rumelhart, 1986; Rumelhart & McClelland, 1986; see also Holyoak & Thagard, 1989; Shultz & Lepper, 1996, 1998; E. R. Smith, 1996; Thagard, 1989). Constraint satisfaction processes are analogized to intricate electrical networks, in which all the attributes of the task are represented as elements, or nodes. One subset of elements (a_1, $a_2 \ldots a_n$) supports Conclusion A, whereas the other subset (b_1, $b_2 \ldots b_n$) supports the opposite Option B. Each element enters with an initial activation that denotes the degree of its acceptability. The links that connect the elements are said to be positive when the elements support the same conclusion (and are thus deemed to *go together*), and negative when the interconnected elements support opposite conclusions. Links can be strong or weak, depending on the substantive relationship between respective elements. In all but the simplest of situations, no single element is independently capable of determining the outcome of the process. Rather, each element both constrains the other elements and is constrained by them in return.

Constraint satisfaction processes operate via cross-activation of the nodes, with each node mutually activating all the nodes to which it is connected, and thus, indirectly, the entire network. Supportive elements excite one another, whereas inconsistent ones have an inhibiting effect. Ultimately, the parallel activations asymptote at an equilibrium of maximal satisfaction of constraints. At this point, the representation of the task has spread apart into two coherent subsets of elements that share similar levels of activity, wherein the elements associated with the winning proposition are highly activated and the elements associated with the rejected conclusion are suppressed. This coherence-maximizing process is understood to *impose* coherent configurations on the representation of the task by which, the emerging conclusion feeds backward to reconfigure the elements and make them cohere with it (Holyoak & Thagard, 1989; Read & Miller, 1994; Read & Simon, 2012; Read et al., 1997; Russo et al., 2008). The ensuing lopsided representation effectively spreads apart the variables into a strong and a weak subset, thus enabling confident decisions and judgments.

This connectionist framework has dramatically broadened the reach of classic cognitive consistency theories, enabling them to capture larger, semantically rich, and more complex tasks that extend beyond the scope of the early formulations of cognitive consistency theories (Read & Miller, 1994; Read & Simon, 2012; Read et al., 1997; D. Simon, 2004; D. Simon & Holyoak, 2002).

Cold and Hot Cognitions

One limitation of the previous experiments on the coherence effect is that their measures pertained only to what has been called "cold cognitions," namely, interpretations of facts, probabilistic judgments, evaluations of attributes, analogies, and so forth. As such, those studies did not tap a slew of reactions that could well be involved in the making of a wide range of important judgments and decisions. A well-established body of research shows that people ubiquitously react to stimuli with a positive or negative valence and liking (e.g., Damasio, 1994; Slovic, Finucane, Peters, & MacGregor, 2004; Zajonc, 1980), easily develop motivations in the form of wishing for or working toward particular goals (M. J. Ferguson, Hassin, & Bargh, 2008; Moskowitz, Li, & Kirk, 2004), and experience emotions toward actors in social situations (Boden & Gross, 2013; Wilkowski, & Robinson, 2010). These reactions have traditionally been labeled "hot cognitions" (see Abelson, 1963; Lepper, 1994; Sorrentino & Higgins, 1986).

The hot cognitions that we set out to explore in these studies include valence, motivation, liking, and emotions. It is important to note that hot cognitions studied here are fundamentally different from the aversive drive state that was postulated to underlie the arousal of cognitive dissonance (Festinger, 1957). We are not concerned with the internal state of aversive conflict, but with the ubiquitous evaluative, motivational, and emotional reactions to everyday life events: how good and how bad people feel about certain situations, motivations and goals with respect to the end states, and the liking, disliking, and emotions toward the actors involved in those situations. Although experiencing intense personal conflict might indeed trigger the arousal of aversive states, aversive arousal is not essential for the more mundane hot cognitive reactions of the kind we are studying here. The distinction between the two types of hot cognitions can be traced to Kurt Lewin's differentiation between the constructs of *tension*, a scalar that maps onto a person's state of arousal, and *direction*, a vector that refers to motivations directed at goals out there in the world (Lewin, 1938; see also Heider, 1960). Likewise, Leon Festinger, Lewin's student, made sure to distinguish between the aversive arousal of dissonance and the "many factors affecting people's behavior, attitudes, and opinions about which the theory of dissonance has nothing to say" (Festinger, 1957, p. 276). Festinger

added that although dissonance itself is to be considered a motivating factor, "there are many other motives which affect human beings and we have skirted the question of any relationship between these other motivations and the pressure to reduce dissonance" (p. 276).

Balance theory sought to encompass, rather than skirt, the reactions that we treat here as hot cognitions. The possibility of incorporating hot cognitions within a cognitive consistency framework was indeed foreshadowed by the inclusion of liking and sentiment relations that link the units represented in the structure (Heider, 1946). At the most basic level, a balanced structure exists when a person likes another person who likes her in return, and imbalance obtains when a person likes someone who dislikes her. Balanced states were postulated to also encompass relationships of love, compassion, esteem, attraction, and approval, as well as envy, rejection, and condemnation (Heider, 1946, 1958; Newcomb, 1968). However, the limited experimental work conducted by balance researchers seems to have ignored hot cognitions (though evidence of the nonhypothesized role of valence can be discerned incidentally from the Fenwick study conducted by Rosenberg & Abelson, 1960).

To operationalize the hypothesized relations between cold and hot cognitions and among the variants of hot cognition, we will resort to informal conventions of which hot cognitions tend to *go with* which judgments and decisions. Normally, people feel positive valence toward favorable situations and good people, feel motivated to bring about desirable outcomes, like people whom they deem to be moral, generous, competent, and so on. People also feel anger toward people who cause bad outcomes and sympathy toward those who are down on their luck. By the same token, it is unusual for people to feel good about adverse states of affairs, to feel motivated to bring about undesirable results, to dislike the hero but like the villain, and to feel angry toward an innocent victim but sympathy toward the one who intentionally inflicting harm upon him.

Research Programs That Link Cold and Hot Cognitions

To be sure, we are not the first to propose that hot and cold cognitions interrelate. Indeed, these interactions have been demonstrated by an array of formidable research programs. For one, cognitive appraisal theories of emotion broke down the longstanding contradistinction between reason and passion, showing instead that emotions are intimately and adaptively linked to the cognitive appraisal of one's environment (Frijda, 1986; Lazarus, 1966; Roseman, 1984; Scherer, 1984; C. A. Smith & Ellsworth, 1985; for a review, see Ellsworth & Scherer, 2003). Thus, for example, emotional reactions to a negative event are strongly influenced by the actor's attribution of the responsibility for its occurrence: Typically, people feel anger toward a person who is appraised to have caused an adverse event, and sympathy toward someone who is deemed to be its victim. Attributing the cause to oneself results in a sense of shame and attributing it to uncontrollable circumstances results in sadness or fear (Ellsworth & Scherer, 2003).

Another body of social psychological research has demonstrated that emotions can influence social judgment. Heightened states of anger have been found to result in stronger attributions of blame for negative outcomes (Goldberg, Lerner, & Tetlock, 1999; Lerner, Goldberg, & Tetlock, 1998; Ohbuchi et al., 2004), and to increase attributions of fault to human conduct rather than to situational conditions (Keltner, Ellsworth, & Edwards, 1993). Sympathy, or the related emotion of compassion (Goetz, Keltner, & Simon-Thomas, 2010), results in greater sensitivity towards people who suffer, thus inhibiting punitive tendencies toward them (Rudolph, Roesch, Greitemeyer, & Weiner, 2004).

Yet another body of social psychological research has demonstrated that reasoning and decision making can be influenced by motivation (Kunda, 1990). Distortions produced by motivated reasoning have been observed in the way people interpret information suggesting a threat to their health (Ditto, Munro, Apanovitch, Scepansky, & Lockhart, 2003), handle challenges to their competence (Wyer & Frey, 1983), perceive the performance of their preferred political candidate (Munro et al., 2002) assess the validity of scientific knowledge (Kahan, Jenkins-Smith, & Braman, 2011), interpret ideologically charged situations (Kahan, Hoffman, et al., 2012), and evaluate the odds of winning a bet on a horse race (Brownstein, Read, & Simon, 2004). Likewise, an abundance of research in the field of judgment and decision making has demonstrated the effect of emotions on decision making (Damasio, 1994; Lerner, Small, & Loewenstein, 2004; Loewenstein & Lerner, 2003; Slovic, Finucane, Peters, & MacGregor, 2002; Wistrich, Rachlinski, & Guthrie, 2014).

It must not be overlooked that these and similar bodies of experimental research suffer from some or all of the following four shortcomings. First, most of the extant findings are confined to interactions between a singular cold cognition—such as a judgment or decision—and a singular hot cognition. For example, motivated reasoning predicts that a particular directional goal will result in a concordant judgment (Kunda, 1990), but it does not predict corresponding valence judgments, liking, or emotions.[1] Second, the extant research programs typically reveal unidirectional effects from one type of cognition to another, say, demonstrating that a directional goal can color a related judgment (Kunda, 1990) or that a particular affective state results in a corresponding decision (Slovic et al., 2002). Rarely do these approaches demonstrate the occurrence of both effects in opposite directions, such as a goal affecting a judgment and that judgment affecting the goal. Third, the extant findings focus on global conclusions, such as decisions and judgments, but neglect to examine how those conclusions interact with the underlying facts from which they are inferred. For example, cognitive appraisal theory focuses on appraisal dimensions, such as the human agency responsible for the event, its novelty, and the implicated norms (Frijda, 1986; Roseman, 1984; Scherer, 1984; C. A. Smith & Ellsworth, 1985). But appraisal theory does not probe beneath these dimensions to examine their interrelationship with their underlying inferences, such as between an attribution of blame and the factual inferences that establish that attribution (D. Simon, Snow, et al., 2004), or between a judgment of a ship captain's responsibility for creating an environmental hazard and the infer-

[1] There are a few exceptions to this observation; for example, anger has been found to influence motivation, such as by increasing the desire for retaliation (T. J. Ferguson & Rule, 1983), and for taking action to remedy the transgression (Mackie, Devos, & Smith, 2000).

ences of his ability to foresee the accident or to exert control over the situation (Nerb & Spada, 2001). Ignoring these important dynamic interactions obscures the manner in which the appraisals themselves can be influenced by the inferences on which they rely and how those inferences can be shaped by those appraisals in return. Fourth, most importantly, the extant findings are rarely grounded in a theoretical framework, and to the best of our knowledge, there is no unified theoretical framework that captures their commonalities. The absence of a shared theoretical framework leaves these invaluable bodies of research in an insular and undertheorized state.

Constraint Satisfaction Simulation Models

A number of theoretical frameworks for connecting cold and hot cognitions have been advanced in the form of simulation models grounded in constraint satisfaction processing. Paul Thagard has proposed a model named HOTCO (short for "hot coherence"), in which each decision alternative is coupled with a node representing the likability or desirability of the corresponding decision, thus forming an overall state of emotional coherence (Thagard, 2006). HOTCO extends Thagard's prior connectionist modeling that pertained only to cold cognitive processing, such as evidence evaluation, analogical reasoning, and decision making (Holyoak & Thagard, 1989; Thagard, 1989; Thagard & Millgram, 1995; for a review, see Thagard, 2000). In a similar vein, Josef Nerb (2007) has offered a parallel constraint satisfaction model whose equilibrium is reached by means of maximizing the coherence between and among the represented beliefs and desires (see also Nerb & Spada, 2001; Thagard & Nerb, 2002). Sander, Grandjean, and Scherer (2005) have offered a neurally inspired appraisal model that draws on constraint satisfaction processing. Lewis (2005) has offered the dynamic systems model, which combines a range of cognitive phenomena with variants of hot cognition. Positive and negative feedback loops and circular causal influences blend together cognition, emotion, and action tendencies to generate an overarching appraisal-emotion amalgam. At the core of Lewis's (2005) model is the principle of self-organization, which refers to the transition from low-order states of mental representations to higher order states, resulting in stable psychological configurations that correspond to the conditions in the person's environment.

The primary goal of the current studies is to extend the coherence effect to include hot cognitions. We seek to test whether the process of reaching judgments and making decisions results in a global state of coherence wherein those judgments and decisions fit together harmoniously with the myriad of both cold and hot cognitions involved in the task. Such a finding would suggest that coherence-based reasoning can help achieve a core goal of cognitive consistency theories by providing a general framework of cognitive functioning, namely, how people engage with their environment in a streamlined, effective, and confident manner (see Abelson, 1983; McGuire, 1968; Newcomb, 1968). Such a finding would also provide empirical support for constraint satisfaction simulation models that posit the interaction between cold and hot cognitions (Lewis, 2005; Nerb, 2007; Sander et al., 2005; Thagard, 2006;). The second goal of this project is to propose coherence-based reasoning as a theoretically based and parsimonious framework to explain the interconnections between cold and hot cognitions that have been observed in the aforementioned experimental research programs that span the fields of social reasoning, emotion research, and decision making.

Overview of Studies

In these studies we present participants with a task of making a social judgment (Study 1) or a decision (Studies 2 through 4). As in previous research on the coherence effect, participants are asked to reach a global conclusion and to draw specific inferences from the complex and ambiguous factual pattern bearing on that conclusion (e.g., Holyoak & Simon, 1999; D. Simon, Snow, et al., 2004). The novelty of the current studies is that we also measure and manipulate hot cognitions, specifically, valence toward each of the eventual outcomes of the focal situation; motivation toward a particular resolution; liking for the protagonists involved in the events; and four emotions felt toward the protagonists: anger, sympathy, sadness and fear.

Study 1 is a correlational, within-subject study that was designed to provide a general test of the interrelationship between cold and hot cognitions. Studies 2, 3, and 4 are based on a between-subjects design. In Study 2 we manipulate one of the facts of the focal situation to explore how it influences the decision, the interpretation of the other facts, and the hot cognitions. In the final two studies, we introduce a reverse manipulation to test the effect of manipulating a hot cognition on the cold judgments and on the other hot cognitions. In Study 3, we manipulate participants' emotion toward the protagonist, and in Study 4, we manipulate participants' motivation to decide the case in favor of one of the parties.

Studies 1 and 2 also contain a pre- to posttest comparison that provides a within-subject test of coherence shifts. As in previous studies, participants are first asked to draw inferences from ambiguous factual situations contained in isolated vignettes that share no plausible or apparent relationship to one another (pretest). At a later stage, they are asked to draw the same inferences from very similar factual situations that are embedded in the larger context of a judgment or decision task (posttest). Finding systematic differences between the responses given on the two tests offers evidence that the process of making decisions and judgments alters the inferences upon which the conclusions rest. Prior research has consistently observed such differences that drive the inferences toward providing stronger support for the emerging conclusion, that is, toward coherent representations of the task.

Given that each of the studies involves a possibility of blaming the protagonist for a norm violation, we expect that the emotion most directly implicated in the attributions of responsibility will be anger (see Goldberg et al., 1999; Lerner, Goldberg, & Tetlock, 1998; Ohbuchi et al., 2004). We predict that the arousal of sympathy and sadness will depend on the particular nature of the task, and that fear will not be implicated at all. Fear, and in all but one study also sadness, were inserted primarily to help isolate the precise emotional reaction and to rule out an overall affective response.

Study 1

Method

Participants and design. Participants were 204 individuals who participated via the Internet. The sample was 52.5% female and 47.5% male. Participants' age ranged from 18 to 78 years ($M = 49.29$, $SD = 14.17$). Of the sample, 83.9% reported having some post-high-school education, with a median of 3 years of post-high-school education. The design of the study was entirely a within-subjects pretest–posttest design, consistent with prior research on the coherence effect.

Materials and procedures. In all studies, participants were recruited through an affiliate of the online survey company Qualtrics, which maintains a very large mailing list of individuals who have consented to participate in online studies in exchange for small fees or rewards (up to the equivalent of $5 per study). Participants first read the consent form and then completed the study online by clicking through a series of web pages that contained the instructions, the case information, the measures, and a demographic questionnaire. At the conclusion of the study, the participants were thanked for their participation.

Pretest. Participants first responded to a set of pretest questions on an instrument entitled "Assessing Social Issues." This instrument contained six isolated vignettes that bore no apparent or plausible relationship to each other. Each vignette concerned an issue in the relationship of a different fictitious couple, and they were all somewhat ambiguous as to the strength of the couple's relationship. As an example, one of the pretest vignettes described an event that occurred between Jeremy and Rachel:

> After being together for three years, Jeremy and Rachel were having some problems in their relationship. One evening, after Jeremy returned from a long day at work, Rachel started to discuss the future of their relationship. A few minutes into the conversation, Jeremy received a telephone call from a friend. After hanging up, he said that he was very tired and needed to go to bed. In the following weeks, neither one of them raised the issue again.

Each vignette was followed by two questions that asked participants to state their agreement with inferences that could be drawn from the behaviors described in the vignette. In each pair, one of the inferences was phrased in a manner that was more consistent with a stable commitment between the couple, whereas the other item was more consistent with a lack of commitment. For example, one inference read, "Jeremy avoided discussing the future of the relationship with Rachel that night because he was very tired," and the second one read, "Jeremy avoided discussing the future of the relationship with Rachel that night because he wanted to avoid the subject." The six vignettes were intermixed with 10 decoy questions that were intended to weaken memory effects. All items were presented in a random order. Unless stated otherwise, the responses in all studies were recorded on 11-point Likert scales, with verbal endpoints of *strongly disagree* and *strongly agree*, with a midpoint labeled *neutral*.

At this point, participants were unaware that these six vignettes were highly similar to the six issues implicated in the focal case of Jenny and Mark, which would be presented later in the main part of the study. Participants were also unaware that they would later be asked to respond to virtually the same questions on the posttest. After responding to the pretest questions, participants performed a distracting task consisting of a number of verbal analogies.

The story of Jenny and Mark. In the main part of the study, participants were presented with information about the relationship of a couple, Jenny and Mark, and were told that they would be asked a number of questions about it. The instructions explained the core task of the study: "In particular, you will be asked to assess how committed Jenny is to the relationship with Mark." After receiving some general information about the couple, participants were provided with a narrative that included a number of recent events in the couple's life. Each of the events offered somewhat ambiguous indications regarding Jenny's commitment to the relationship, with some being more suggestive that Jenny is not committed to Mark (e.g., her failure to show up to a dinner with Mark's parents), and others suggesting that she is committed (e.g., she took Mark to a special family event that was restricted to immediate family only). Importantly, these events mirrored the six vignettes in the pretest, except that all the events were now incorporated into the relationship between Jenny and Mark.

Dependent variables. After receiving the narrative about Jenny and Mark, participants answered a series of dependent variables to assess their judgments of Jenny and Mark's relationship.

Valence. To gauge participants' reaction to the eventual outcome of the relationship, participants were requested to imagine that the couple had broken up, and to report how good they felt about that eventuality ("How good does the thought of the breakup make you feel?") and how bad they felt about it ("How bad does the thought of the breakup make you feel?"). Likewise, participants were asked to predict how good and how bad they would feel about the prospect of Jenny and Mark staying together. The endpoints of the scales were labeled *not good at all* to *very good*, and *not bad at all* to *very bad*, respectively. All four items were composited into a variable of *valence* ($\alpha = .83$; the first and last question were reverse coded so that all questions were in the same direction, with high values representing a favorable reaction toward the prospect of the couple staying together).

Motivation. Motivation toward the outcome of the relationship was assessed by asking participants, "What would you like to see happen with Jenny and Mark's relationship?" Specifically, participants were asked "To what extent would you like to see them breaking up or staying together?" Responses were given on an 11-point scale ranging from *strong preference to see the couple break up* to *strong preference to see the couple stay together*. In all studies, the measures of valence and motivation were presented in a randomized order.

Judging Jenny's commitment. Participants were asked for their judgment of Jenny's commitment to the relationship in two ways: first, by means of a dichotomous choice ("In your opinion, is Jenny seriously committed to the relationship with Mark?" with response options of "Yes, Jenny is seriously committed to the relationship with Mark" and "No, Jenny is not seriously committed to the relationship with Mark"). The commitment judgment was also measured as a continuous variable on a 100-point scale ranging from *not committed at all* to *strongly committed*. The binary commitment question is labeled the *commitment judgment* and the continuous item is labeled *degree of commitment*.

Liking. Participants were asked how much they liked Jenny, first on an 11-point scale (ranging from *strongly dislike Jenny* to

strongly like Jenny) and then on a "feeling thermometer" (a scale of 0 to 100, ranging from *very unfavorable* to *very favorable*). *Z*-scored versions of the two liking items formed a reliable composite ($\alpha = .93$). Identical questions were then administered to gauge participants' liking of Mark, forming a reliable composite ($\alpha = .88$).

Emotions. Participants were then asked how they felt toward Jenny on 10 emotion items, which were clustered into four composites: *anger* (comprised of angry, disdainful, disgusted), *sympathy* (sympathy, compassion, sorry for), *fear* (afraid of, scared by), and *sadness* (sad, melancholic). The emotion measures used a 7-point scale (ranging from *not at all* to *very much*), and were presented in a randomized order. The groupings formed reliable composites ($\alpha = .88, .71, .85, .71$, respectively). Identical questions were then administered to gauge participants' emotions toward Mark, forming reliable composites ($\alpha = 77, .84, .78$, and .74, respectively). In all studies, the emotion items were presented in a randomized order.

Factual inferences ("posttest"). Participants were then asked to indicate their agreement with 12 factual inferences related to the case (which were virtually identical to the pretest items). For example, with respect to the incident in which Jenny did not resume the discussion of the future of the relationship, participants were asked to state their agreement with the statements "Jenny avoided discussing the future of the relationship with Mark after getting off the phone that night because she was very tired," and "Jenny avoided discussing the future of the relationship with Mark after getting off the phone that night because she wanted to avoid the subject." As in the pretest, responses were recorded on 11-point scales, ranging from *strongly disagree* to *strongly agree*. The items that indicated that Jenny is committed to the relationship are labeled *committed items*, and the items that suggest a lack of commitment are labeled *not-committed items*. In all studies, the posttest items were presented in a randomized order.[2]

Demographics. In all three studies, we collected a range of demographic information, none of which revealed any important interactions with the results. For the sake of brevity, we will report only on the participants' gender, age, and education level, which are reported in the Participants and Design section.

Results

We analyzed the data from 178 participants. Data were not analyzed for the 26 participants who did not complete the study within the designated time frame, between 13 min and 1 hr (we used the same time cutoffs for all studies).

As a first pass at the data, we examined whether participants had coherent mental representations by the end of the judgment process. Table 1 looks at the inferences for participants grouped separately by their responses to the dichotomous *commitment judgment* measure. As predicted, the responses provide strong support for the coherence effect: Those who concluded that Jenny is committed to the relationship agreed more strongly with the committed items and less strongly with the not-committed items, and vice versa for those who concluded that she is not committed to the relationship.

Importantly, the participants' judgments also cohered with their reported hot cognitions. We predicted that concluding that Jenny is not committed to the relationship would be viewed as dishonest behavior, and thus result in more negative valence toward the continuation of the relationship, less liking of Jenny, a stronger motivation to see the couple break up, and greater anger toward Jenny. Under this view of the relationship, Mark would be perceived to be on the receiving end of Jenny's dishonesty, which would lead participants to feel greater sympathy and sadness toward him, but not anger. We had no clear hypothesis with respect to sympathy and sadness toward Jenny, because one can imagine observers having opposite reactions toward her on these dimensions. As in all of the present studies, we predicted that the measure of fear would not be related to any of the other judgments and thus be uninfluenced by the emerging coherence. As can be seen in Table 1, these predictions were borne out. The opposite nature of the emotions expressed towards Jenney and towards Mark indicates that we are not observing general mood states, but rather concrete and directed emotions that cohere with the participants' appraisal of the protagonists and their deeds.

To replicate prior findings of coherence shifts, we examined the results in a mixed factorial analysis. We tested whether, over the course of the study, the inferences drawn from the facts shifted toward greater coherence with the eventual judgment of Jenny's commitment to the relationship. To examine this shift, we compared responses on the pretest and the posttest, grouping participants by their commitment judgment and looking separately at the committed items and the not-committed items. Consistent with past coherence shift research (D. Simon, Snow, et al., 2004), the interaction between the 2 (pretest vs. posttest) $\times$ 2 (committed items vs. not-committed items) $\times$ 2 (commitment judgment: Jenny is committed vs. Jenny is not committed) mixed-factorial design was highly significant, $F(1, 175) = 85.98$, $p < .001$. To understand the nature of the coherence shift, a follow-up two-way ANOVA was conducted to test the interaction between pretest–posttest and type of item (committed vs. not-committed items) separately for both those participants who concluded that Jenny is committed to the relationship and those who concluded that Jenny is not committed (commitment judgment variable). The left panel of Figure 1 displays the pretest and posttest scores of participants who concluded that Jenny is committed to the relationship, plotted separately for the committed items and the not-committed items. The 2 $\times$ 2 repeated measures analysis was significant, as predicted, $F(1, 64) = 25.58$, $p < .001$. The right panel displays the same responses for participants who concluded that Jenny is not committed to the relationship, with another significant 2 $\times$ 2 repeated measures interaction, $F(1, 111) = 81.68$, $p < .001$. As shown in Figure 1, the factual inferences shifted toward greater coherence with the participants' overall judgment of the situation.

[2] To obtain a fuller picture of the participants' evaluations of the task, the materials included measures to probe additional aspects of Jenny's character and predictions of the couple's future. Participants' responses to these items were invariably supportive of the coherence effect: for example, those who concluded that Jenny is committed to the relationship judged her character more favorably and predicted that the couple would enjoy a good relationship into the future (compared with participants who concluded that Jenny is not committed to the relationship). Measures of this kind were included also in Studies 2, 3 and 4, and they, too, yielded results that were supportive of the coherence hypothesis. Because of space considerations, these measures and results will not be discussed further.

Table 1
Dependent Measures Grouped by Judgments of Jenny's Commitment (Study 1)

	Participants who concluded that Jenny is not committed (n = 112)	Participants who concluded that Jenny is committed (n = 65)		
	Mean (*SD*)	Mean (*SD*)	F	η^2
Cold cognitions				
Degree of commitment	40.48 (14.65)	76.95 (10.06)	312.01***	.64
Posttest NC	1.75 (1.52)	−.05 (1.30)	63.71***	.27
Posttest C	.84 (1.49)	2.71 (1.22)	73.82***	.30
Hot cognitions				
Valence (staying together)	4.89 (1.53)	6.97 (1.19)	89.35***	.34
Motivation (staying together)	5.60 (2.44)	8.85 (1.68)	90.03***	.34
Liking of Jenny	−.53 (.68)	.89 (.69)	177.00***	.50
Anger toward Jenny	3.02 (1.49)	1.65 (.93)	44.54***	.20
Sympathy toward Jenny	2.73 (1.23)	3.11 (1.38)	3.53	.02
Sadness toward Jenny	2.61 (1.42)	2.00 (1.21)	8.38**	.05
Fear of Jenny	1.72 (1.21)	1.48 (.96)	1.79	.01
Anger toward Mark	1.60 (.97)	1.48 (.86)	.66	.004
Sympathy toward Mark	4.70 (1.49)	3.34 (1.42)	35.22***	.17
Sadness toward Mark	3.27 (1.63)	2.17 (1.21)	22.48***	.11
Fear of Mark	1.28 (.83)	1.32 (.77)	.11	.001

Note. Posttest NC = posttest factual inferences from the not-committed items; Posttest C = posttest factual inferences from the committed items.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Relative to their own pretest responses, on the posttest participants more strongly endorsed factual inferences that cohered with their overall judgments of Jenny's commitment.

The coherence effect was also confirmed by means of an intercorrelational analysis of all 12 items that measured participants' factual interpretations. After reverse coding the not-committed items, the analysis produced a highly reliable composite for all 12 items (α = .82), whereas the items from the pretest did not form a reliable composite (α = .43), despite the virtual similarity between the sets of measures. Table 2 shows the correlation matrix for the main variables measured in the study: the overall judgment of Jenny's commitment to the relationship (degree of commitment), posttest inferences (committed items, not-committed items), valence, motivation, liking of Jenny, anger toward her, and sympathy toward Mark. Notably, every one of the variables correlates significantly with each and every one of the other variables,

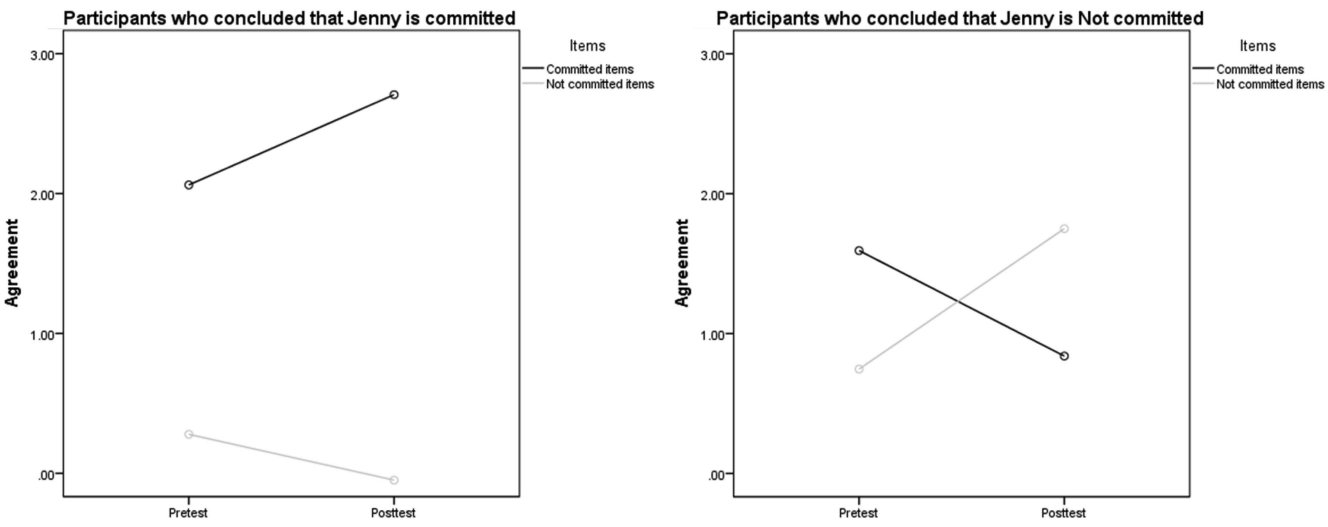

Figure 1. Coherence shifts in Study 1. Left panel shows the means of the factual inferences at pretest and posttest for participants who concluded that Jenny is committed to the relationship, plotted separately for committed-items and for not-committed items. The right panel shows the same responses for participants who concluded that Jenny is not committed to the relationship. The 11-point scale (which contained labels of *strongly disagree*, *neutral*, and *strongly agree*) was converted to a −5 to +5 scale to allow a zero comparison point for the neutral option.

Table 2
Intercorrelations Among Key Measures (Study 1)

	1	2	3	4	5	6	7
1. Degree of commitment							
2. Committed items	.63***						
3. Not-committed items	−.55***	−.56***					
4. Valence (staying together)	.66***	.58***	−.52***				
5. Motivation (staying together)	.72***	.62***	−.50***	.78***			
6. Liking Jenny	.75***	.65***	−.56***	.65***	.63***		
7. Anger toward Jenny	−.54***	−.51***	.53***	−.44***	−.39***	−.60***	
8. Sympathy toward Mark	−.42***	−.37***	.42***	−.33***	−.35***	−.46***	.59***

* $p < .05$. ** $p < .01$. *** $p < .001$.

suggesting a pervasive state of coherence throughout the representation of the task (all correlations $p < .001$; two-tailed).

Discussion

The findings of Study 1 are indeed consistent with the primary hypothesis. As expected, we found that all measures cohered with whichever conclusion participants reached with respect to Jenny's commitment: the 12 factual inferences drawn from the ambiguous factual pattern, the valence toward the relationship, the motivation to see it get resolved in a particular manner, the liking of Jenny and anger toward her, and the liking, sympathy, and sadness toward Mark. This study successfully extended coherence-based reasoning beyond the realm of cold cognitive judgments, showing that the coherence effect also sweeps through the hot cognitions that *go with* the cold judgments of the situation.

To be sure, the theoretical claims that can be drawn from this correlational study are limited. It is possible that this consistent pattern of results could have been driven by an unnoticed covariate or by endogenous properties of the materials. To rule out this alternative explanation, the next three studies contained experimental manipulations designed to provide greater insight into the spreading of coherence between and among cold and hot cognitions. If, as we hypothesize, the coherence effect encompasses both cold and hot cognitions, we would expect that altering the perception of a situation should trigger a corresponding change in hot cognitions that *go with* the respective perception, just as manipulating hot cognitions should trigger corresponding changes in the cold perception of the situation.

The following studies ask participants to determine whether a protagonist should be blamed for an alleged violation of a social norm: a murder in Study 2 and cheating on an exam in Studies 3 and 4. The studies contain substantial factual ambiguity concerning the key dimension of human agency, that is, whether the protagonists did in fact commit the transgressions. We predict that conclusions of guilt are bound to be accompanied by stronger endorsement of factual inferences that suggest that the protagonists did indeed transgress (and weaker endorsement of inferences that suggest their innocence), positive valence toward seeing the protagonists get punished (and negative valence to seeing them go unpunished), higher motivation to see them suffer the consequences of their deeds, stronger dislike and anger toward them, and weaker sympathy. Conclusions of innocence are predicted to be accompanied by opposite judgments and feelings.

In designing the studies, we felt that the strongest proof for our hypotheses would come from studies that manipulate hot cognitions and demonstrate the ensuing effect on cold cognitive judgments and decisions. That task will be tackled in Studies 3 and 4. First, though, we thought it useful to ensure that coherence will spread from a manipulation of a cold cognition toward hot cognitions, which is the subject of Study 2.

Study 2

Method

Participants. Participants were 603 individuals who participated via the Internet. The sample was 49.8% female and 49.8% male. Participants were all 18 years or older, ranging from 18 to 80 ($M = 48.40$, $SD = 14.27$). Of the sample, 82.2% reported having some post-high-school education, with a median of 3 years of post-high-school education.

Design. The design of the study included both between-subjects and within-subjects features. The main purpose of the study was to test the between-subjects effect of strengthening one of the pieces of evidence in the criminal prosecution brought against the defendant, Jason Wells. This manipulation was predicted to drive coherence shifts throughout the entire task, including the verdict choice, the inferences drawn from the other evidence in the case, and the hot cognitions pertaining to the case and to the defendant. The manipulation was intended to capture the intuitive sense that strengthening the evidence against a murder suspect should make him appear guiltier, which should in turn influence the hot cognitions that *go together* with a judgment of criminality: more positive valence toward the prospect of finding him guilty, increased motivation to see him get convicted, and greater disliking of him. Consistent with appraisal theory, we also predicted that tightening the evidence against Jason would increase judgments of his human agency in the perpetration of the murder, which would lead to heightened anger and less sympathy toward him. The study was also designed to replicate previous findings of the coherence effect, by implementing a pretest–posttest within-subjects design that allowed us to observe coherence shifts over the course of the experiment.

Materials and procedures. The materials used in this case were based on a shortened version of a fictional criminal case that has been used in studies by D. Simon, Snow, et al. (2004) and Glöckner and Engel (2013a, 2013b). Participants were recruited in

the same manner as Study 1. Participants first read the consent form and then completed the study online by clicking through a series of web pages that contained the instructions, the case information, and the measures. At the conclusion of the study, participants were thanked for their participation.

Pretest. Similar to Study 1, participants first responded to a set of pretest questions embedded in a series of vignettes that had no plausible connection to each other. The questions asked participants to state their agreement with inferences drawn from ambiguous factual situations. For example, participants were given information about Beth, a doctoral student, who was scheduled to present her thesis at an important conference on campus at 7:30 one evening. Forty minutes before the talk, she discovered that she had forgotten the poster at home. She called her husband and asked him to bring the presentation in a hurry, a drive that typically takes 45 min. Participants were asked to state their agreement with "It is unlikely that Beth's husband could make it in time for the 7:30 PM presentation." In all, the pretest consisted of four factual inferences and 10 decoy questions that were unrelated to the case.[3] After responding to the pretest questions, participants performed a distracting task consisting of a number of verbal analogies.

The case against Jason Wells. In the main part of the study, participants were asked to role-play a juror in a criminal trial. Jason Wells was accused of murdering a security guard who encountered him as he was stealing $5,200 from his employer's safe. All participants received the same instructions and evidence, except for the manipulation, as described later. The evidence was mostly circumstantial, and it was intricate and ambiguous. The evidence was presented in 11 web pages, containing testimony of an eyewitness, a police detective, a medical examiner, the company's bookkeeper, and other employees.

The evidence presented in the case included a number of facts that tended to support the conclusion that Jason Wells was guilty of the crime: an eyewitness identified Jason as the man seen rushing from the crime scene; a forensic examiner testified that a fingerprint found at the crime scene provided "about a 98%" match with Jason's fingerprints; 3 days after the crime, Jason repaid a debt of $4,870 to his credit card company; and a couple of months prior to the incident, Jason was disciplined by his boss (there was reason to suspect that he wanted to get back at his employer). Other items tended to support Jason's innocence: Jason offered an innocuous explanation for the source of the money he used to repay the credit card company. He also provided an alibi, namely, that he was seen that evening by a manager of his firm picking up his child from a swim meet about 40 min after the crime occurred. The manager testified that at that time of day, it typically takes 45 min to get from the office to their neighborhood. Each of the evidence items was essentially identical to the facts contained in the vignettes included in the pretest. For example, the alibi raised the same issue as the vignette about Beth, the doctoral student, who asked her husband to rush her poster across town during evening traffic. Importantly, all of these evidence items were mutually independent of one another. In other words, there was no plausible way to perceive an interrelationship among the evidence items, short of via the hypothesized coherence effects.

Manipulation. The manipulation was performed by altering one of the evidence items. In one condition, the eyewitness who identified Jason Wells as the perpetrator stated that he was "absolutely certain" in his identification, whereas in the other condition he was "not certain at all". Given the general tendency to rely heavily on eyewitness confidence (see Cutler, Penrod, & Dexter, 1990; D. Simon, 2012), we expected that this piece of evidence would sway the judgments of Jason's guilt. Coherence-based reasoning would predict that this shift in propensity to convict Jason would also result in shifts in the inferences drawn from the other items of evidence. We expected that these coherence shifts would also result in concordant shifts in participants' hot cognitions. Following the introduction of the evidence, participants were tested for their memory of the manipulation.[4]

Dependent variables. Following the presentation of the evidence, participants answered a series of dependent variables to assess their reactions to the case.

Valence. Participants were requested to imagine that Jason was cleared of all charges, and were then asked for their assessment of how good and how bad they felt about that scenario. Similar questions were posed with respect to the prospect of Jason getting convicted of the murder charge. All items were composited into a variable of overall valence ($\alpha = .88$; two of the four items were reverse coded so that all questions were in the same direction, with high values representing positive valence toward the prospect of a conviction).

Motivation. Motivation toward the outcome of the case was assessed by asking participants, "Regardless how you will decide the case, how would you like to see it come out?" ranging from *strong preference to see Jason cleared of the charges* to *strong preference to see Jason found guilty*.

The verdict: Deciding Jason's guilt. Participants were asked to report their verdict (a dichotomous choice between "Yes, I find him guilty" and "No, I find him not guilty"), and then to separately assess the likelihood that the crime was committed by Jason, using a continuous measure ranging from 0, *did not commit the crime*, to 100, *definitely did commit it* (*likelihood*).

Liking. Participants were asked how much they liked Jason on a 11-point scale ranging from *strongly dislike him* to *strongly like him*, with *neutral* at the midpoint of the scale. Participants also

[3] To explore the depth of the coherence effect, we also tested whether it would spread into the background beliefs that inevitably inform the inferences made by our participants (on the role of personal knowledge structures in reasoning, see Read, 1987; Schank & Abelson, 1995; Wyer & Radvansky, 1999). Such an effect could be inferred from differences between statements of relevant background knowledge given on the pretest and the posttest. To test this prospect, participants were also asked to state their agreement with background knowledge beliefs pertaining to the inferences they drew. For example, following the question concerning the likelihood that Beth's husband would be able to deliver her poster in time for the presentation, we stated, "When driving in evening traffic, no matter how aggressively one drives, it is very difficult to shorten the travel time substantially." An identical belief question followed the corresponding item in the posttest (Jason's alibi). Consistent with prior research (D. Simon, Snow, Simon et al., 2004), a comparison between the ratings given on the pretest and posttest revealed significant coherence shifts not only the inferences drawn from the facts, but also in the background beliefs pertaining to those inferences. Because of space considerations, the measures and results concerning background knowledge will not be discussed further.

[4] One hundred seventy participants failed to recall the manipulation correctly (which might have been caused by the fact that the confidence of the eyewitness was just one of many facts presented to the participants). Nonetheless, we included these participants in the analysis. Excluding these subjects did not change the results.

answered a "liking thermometer" on a scale of 0 to 100, with higher scores indicating more liking. The two measures formed a reliable composite ($\alpha = .90$).

Emotions. Participants' emotions toward Jason were measured with the same instrument used in Study 1: anger, sympathy, fear, and sadness. The respective Cronbach's alpha values were .88, .86, .90, and .57.

Factual inferences ("posttest"). Participants were then asked to state their agreement with four factual inferences that were the key pieces of evidence in the case. Two of the inferences supported a conclusion of guilt (guilt facts). For example, participants were asked to state their agreement with, "The forensic examiner's testimony proves that Jason Wells committed the crime." The remaining two inferences supported a conclusion of innocence (innocence facts). For example, with respect to Jason's alibi, participants were asked to state their agreement with, "If Jason had committed the crime, it is unlikely that he could have made it in time for the swim meet." The four factual inference questions were phrased very similarly to the questions in the pretest, except that they pertained to the case of Jason Wells. To assess the effect of the manipulation, a question was included to gauge participants' assessment of the significance of that piece of evidence. Participants were asked for their agreement with the proposition, "The computer technician's identification of Jason proves that it was Jason who committed the crime" (the eyewitness-manipulation question).

Demographics. Finally, participants responded to demographic questions about their age, gender, and educational experience.

Results

The data included responses from 538 participants, after discarding 65 participants for failing to complete the study in the designated time frame.

Within-subject findings. We first examined whether the inferences drawn from the case facts shifted toward greater coherence with the eventual verdict. To test for this shift, we compared the inferences drawn from the isolated vignettes (pretest) and from the legal case (posttest), grouping participants according to their verdict choice: those who voted to convict Jason ("convictors") versus those who chose to acquit him ("acquitters"). We expected the former to give higher ratings on guilt facts and lower ratings on innocence facts, with the latter group showing opposite shifts. Replicating Glöckner and Engel (2013a) and D. Simon, Snow, et al. (2004), the three-way interaction in the 2 (pretest vs. posttest) $\times$ 2 (guilt facts vs. innocence facts) $\times$ 2 (convictors vs. acquitters) mixed-factorial design was highly significant, $F(1, 535) = 336.18$, $p < .001$. To understand the nature of the coherence shift, the follow-up two-way interaction between pretest–posttest and guilt–innocence items is displayed in Figure 2 separately for convictors and acquitters. The 2×2 interaction is significant for both the left-hand side of Figure 2 showing the convictors, $F(1, 256) = 248.42$, $p < .001$, and the right-hand side of Figure 2 showing the acquitters, $F(1, 279) = 97.90$, $p < .001$.

Similar to Study 1, the coherence effect was confirmed also by means of an intercorrelational analysis to show the high level of interrelationship among all the judgments about the case (after reverse coding the Innocence Facts so that all questions were coded in the same direction). The analysis produced a highly reliable composite for all four items ($\alpha = .75$), which was higher than at the pretest phase ($\alpha = -.03$). In other words, participants developed globally coherent factual patterns that tended to indicate that Jason was either guilty or not guilty.

Between-subjects findings. A central contribution of this study was the inclusion of a manipulation, which was designed to shift participants toward higher rates of conviction. First, however, we tested whether the manipulation had the predicted effect on the intended evidence item. To test this effect, a one-way ANOVA of

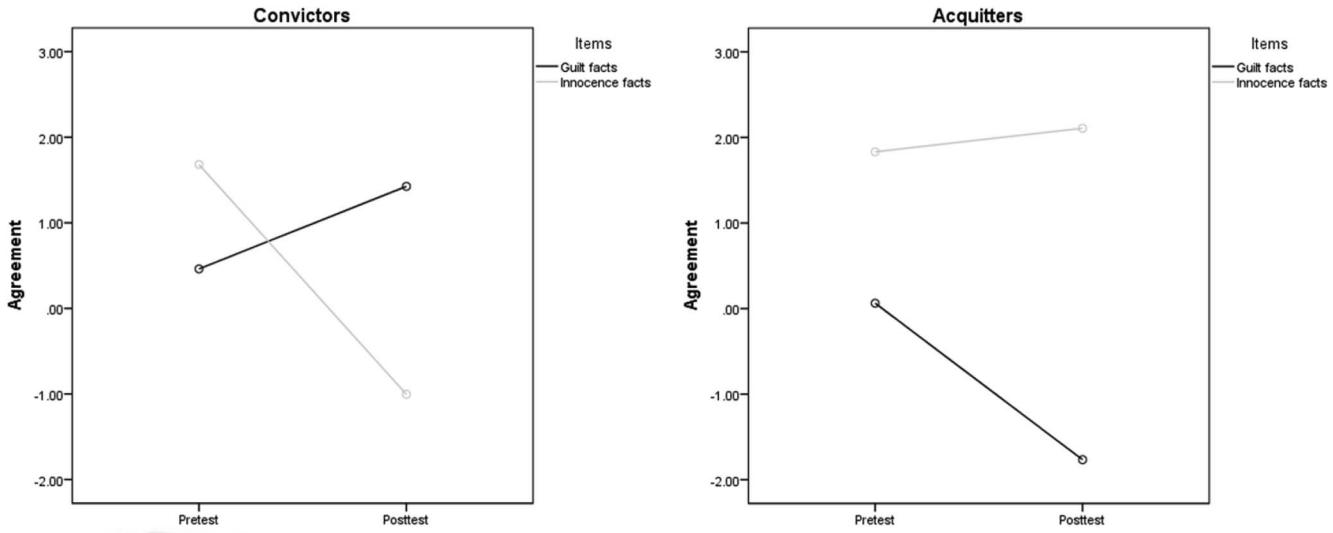

Figure 2. Coherence shifts for Study 2. Left panel shows combined means of factual inferences at pretest and posttest, for participants who decided Jason was guilty (convictors), plotted separately for guilt facts and innocence facts. The right panel shows the same information for those whose verdict choice was "not guilty" (acquitters). The 11-point scale (which contained labels of *strongly disagree*, *neutral*, and *strongly agree*) was converted to a -5 to $+5$ scale range in SPSS to allow a zero comparison point for the neutral option.

the between-subjects experimental treatment was performed on the eyewitness confidence question. As expected, those in the high-certainty condition were more likely to infer that the identification proved that Jason was the person who committed the crime (M = .36, SD = 3.14) than those in the low-certainty condition ($M = -2.00$, $SD = 2.70$), $F(1, 534) = 86.62$, $p < .001$, $\eta^2 = .14$. The 11-point scale range was coded from −5 to 5, so a higher response indicates agreement that the identification of Jason proves that he committed the crime, consistent with the intended purpose of the manipulation.

The straightforward prediction was that the manipulation would influence participants' verdict choices, with the more confident eyewitness testimony resulting in more guilty verdicts. This prediction was indeed borne out by the data. Those in the high-certainty condition were more likely to vote guilty (60.9%) compared with those in the low-certainty condition (34.6%), $\chi^2(1, N = 537) = 37.21$, $p < .001$.

As predicted, we found that the manipulation triggered concordant shifts in all factual inferences drawn from the other items of evidence, as well as in the hot cognitions that *go together* with the decision of finding a person guilty of a violent crime. As seen in Table 3, strengthening the confidence of the eyewitness resulted in positive valence toward the prospect of Jason getting convicted (and negative valence toward seeing him be cleared of the charge), a stronger motivation to see him convicted, stronger disliking of him, and greater anger and less sympathy toward him. The manipulation had no significant effect on the emotions of fear and sadness, which were not predicted to be implicated in the decision. Table 4 shows the correlation matrix for the main variables in the study, both cold and hot: condition (the manipulation of the witness confidence vs. control), three cold cognitions—the judgment of continuous verdict choice (likelihood of guilt), and posttest evaluations of facts (guilt facts, innocence facts)—and four hot-cognition items: valence, motivation, liking, and emotions, namely, anger/sympathy. All but one of the correlations were highly significant ($p < .001$, two-tailed).

Discussion

This study found that changing one piece of evidence altered participants' judgments of Jason's guilt, their interpretation of the facts of the case, and the hot cognitions that *go together* with that conclusion. These results replicate and extend the findings of Study 1, showing that the concordant shifts in the cold and hot cognitions are most likely driven by the coherence effect, rather than by an unobserved covariate.

The next two studies were designed to test the opposite vector in bidirectional processing: that the manipulation of a hot cognition will result in concomitant changes in the ensuing decision, its underlying factual inferences, and in the other hot cognitions. Both studies are based on a new set of materials in which participants are asked to play the role of a university administrator, assigned to adjudicate an allegation of academic misconduct against a student by the name of Debbie Miller. Study 3 contains a manipulation of emotion toward Debbie, and Study 4 manipulates participants' motivation to see the case come out in a particular manner. Both manipulations were designed to be orthogonal to the alleged misconduct.

Study 3

Study 3 contains a manipulation that was designed to alter participants' emotion toward Debbie by triggering feelings of sympathy and hindering feelings of anger toward her. Given that heightened sympathy and inhibited anger are likely to go with judgments of innocence, we predict that propagating sympathy toward Debbie will reduce the likelihood of finding her guilty, and thus also result in drawing factual inferences that suggest her innocence and in concomitant hot cognitions, namely, more positive valence associated with her being cleared of the charges, greater motivation to see her prevail, and greater liking of her.

To provide a meaningful test for our predictions, we designed the manipulation to generate emotions that are directed at Debbie,

Table 3
Dependent Measures Grouped by Condition (Study 2)

	Low-certainty condition (n = 267)	High-certainty condition (n = 271)		
	Frequency	Frequency	χ^2	
Cold cognitions				
Decision (% guilt)	34.6%	60.9%	37.21***	
	Mean (*SD*)	Mean (*SD*)	F	η^2
Likelihood of guilt	53.26 (29.45)	67.43 (30.71)	28.90***	.05
Guilt facts (posttest)	−.66 (2.59)	.18 (2.54)	14.44***	.03
Innocence facts (posttest)	1.05 (2.34)	.19 (2.61)	15.98***	.03
Hot cognitions				
Valence (Jason found guilty)	5.36 (2.17)	6.39 (2.49)	25.99***	.05
Motivation (Jason found guilty)	4.74 (2.32)	6.10 (2.70)	38.82***	.07
Liking Jason	.10 (.81)	−.12 (1.05)	7.55**	.01
Anger toward Jason	2.70 (1.57)	3.20 (1.78)	11.64***	.02
Sympathy toward Jason	3.68 (1.48)	3.30 (1.59)	8.17**	.02
Fear of Jason	2.12 (1.46)	2.17 (1.50)	.17	.0003
Sadness toward Jason	3.13 (1.44)	3.01 (1.46)	.78	.001

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4
Intercorrelations Among Key Measures (Study 2)

	1	2	3	4	5	6	7
1. Condition							
2. Likelihood of guilt	−.23***						
3. Guilt facts (posttest)	−.16***	.63***					
4. Innocence facts (posttest)	.17***	−.62***	−.51***				
5. Valence (Jason found guilty)	−.22***	.66***	.58***	−.61***			
6. Motivation (Jason found guilty)	−.26***	.70***	.61***	−.62***	.82***		
7. Liking toward Jason	.12**	−.45***	−.42***	.52***	−.58***	−.57***	
8. Anger/Sympathy toward Jason	−.18***	.58***	.56***	−.53***	.72***	−.66***	.65***

* $p < .05$. ** $p < .01$. *** $p < .001$.

rather than inducing a general affective state. Thus, we chose to manipulate the participants' integral, as opposed to incidental, emotions (Loewenstein & Lerner, 2003). Specifically, we chose to test the effect of sympathy on the judgments of Debbie's alleged cheating. This was done by informing participants in the treatment condition of a tragic event that occurred in Debbie's family life: A few months before the cheating incident, her teenage brother was killed by a drunken driver while riding his bicycle. Devising an opposite manipulation that would increase integral anger toward Debbie while being orthogonal to the task proved to be a difficult feat. A commonly used way to trigger anger toward a person is to provide information about some untoward behavior that he or she performed in a past event. However, doing so would risk altering participants' views of that person's character, making her seem more likely to misbehave in the current occasion (see Cantor & Mischel, 1979). Such a manipulation would make it difficult to distinguish between the coherence effect and a more direct influence on the protagonist's character. Hence, this study contains a single manipulation that was designed to increase the sympathy toward Debbie compared with a control condition with no manipulation.

Method

Participants. Participants were 489 individuals who participated via the Internet. The sample was 52.0% female and 48.0% male. Participants' age ranged from 18 to 89 years (M = 44.94, SD = 16.56). Of the sample, 84.6% reported having some post-high-school education, with a median of 3 years of post-high-school education.

Design. This study assigned participants to determine whether a college student by the name of Debbie Miller had cheated on an exam and thus should be punished by the university. The main purpose of the study was to test the between-subjects effect of manipulating the participants' emotion toward Debbie.

Materials and procedures. Participants were recruited in the same manner as Studies 1 and 2. Participants first read the consent form and then completed the study online by clicking through a series of web pages that contained the instructions, the case information, and the measures. At the conclusion of the study, participants were thanked for their participation.

The case of Debbie Miller. Participants were asked to role-play a "Judicial Officer" employed in the office of the Dean of Students at a state university. The instructions explained that their task was to adjudicate allegations of academic misconduct. The particular case involved an allegation that a student by the name of Debbie Miller copied from her notes in a closed-book exam. All participants received the same case information and instructions, except for the manipulation. They were all instructed to decide the case based on a fair and objective examination of the evidence.

Participants were first given background information about the case, describing Debbie as an "A student," hardworking, and ambitious. In the 10th grade, Debbie was caught cheating on an exam, for which she received an F and was suspended from school for 2 weeks. Debbie was the captain of her high-school volleyball team, which went on to win the state championship. She was awarded an athletic scholarship to play on the college volleyball team, but quit the team in her freshman year after complaining of lower back pain.

Immediately following the background information, one half of the participants were randomly assigned to the tragic-information condition, which read as follows:

> Four months before this incident, Debbie lost her younger brother, Dylan. Dylan was a senior in high school. He was an outstanding student and the captain of the varsity swimming team. Early one morning, while riding his bike to a swim practice, Dylan was hit by a car that was swerving wildly across the lanes and traveling at twice the speed limit. Dylan was injured badly, and died three weeks later. He never regained consciousness. It is believed that the driver was drunk. The police have not yet managed to catch the driver.

There was no mention of Debbie's brother in the control condition.

The bulk of the evidence was derived from interviews conducted with three witnesses and with Debbie Miller herself. Overall, the facts of the case were intricate and ambiguous, with some facts making it seem like she cheated and other facts suggesting that she did not. The proctor, Ms. Simmons, reported that during the exam, Debbie sat against a wall in the back corner of the room, and was crouched over her papers, as if she was hiding something. At the end of the exam, the proctor noticed that Debbie stuck something into the pocket of her sweater, which later turned out to be a note that contained a summary of the course materials. The interview revealed that this was the proctor's first time proctoring an exam for the university, and that she was hoping to keep the job. Prior to the exam, she was told by another proctor to watch Debbie closely. Next, a fellow student who sat behind Debbie during the exam

claimed to have seen her pull out the note from her sweater pocket and copy from it during the exam. The course professor stated that he trusted that Debbie did not cheat, describing her as a very good student and a hard worker. He said also that she was usually very well prepared for class and that she participated frequently and intelligently in classroom discussions. In his opinion, some of Debbie's classmates envied her because of her high grades and active participation. Debbie denied the allegations adamantly. She explained that as an aspiring academic, she had too much at stake, stating "It would be stupid of me to risk my career." Debbie explained also that she crouches when sitting for long periods of time because of a back injury she sustained while playing on the college volleyball team.

Dependent variables. Following the presentation of the case, participants answered a series of dependent variables.

Valence. To better differentiate between the valence and the motivation measures, we framed the former in terms of the anticipated punishment and the latter in terms of winning the case. Participants were asked to evaluate the prospect of seeing Debbie being cleared of the misconduct charge and suffering no consequences ("How does the thought of Debbie being cleared of the charges make you feel?" with end points of *very bad* to *very good*, with *neutral* at the midpoint of the scale). The same measure was used to evaluate the prospect of Debbie being disciplined for cheating. After reverse coding the first item, we constructed a composite valence variable ($\alpha = .73$) so that high values represented positive valence toward the prospect of Debbie being found guilty of misconduct.

Motivation. Motivation toward the outcome of the case was assessed by asking participants, "Regardless how you will decide the case, which side would you want to see win it?" ranging from *strong preference to see Debbie win* to *strong preference to see the university win.*

The decision: Did Debbie cheat? Participants were asked to determine whether Debbie cheated (a dichotomous choice between "Yes, Debbie Miller cheated on the exam" and "No, Debbie Miller did not cheat on the exam"). Participants were then asked to assess the likelihood that Debbie Miller did in fact cheat on the exam, using a continuous measure ranging from 0, *definitely did not cheat*, to 100, *definitely cheated* (the likelihood measure).

Liking. Participants were asked how much they liked Debbie Miller on an 11-point scale, and on a liking thermometer on a scale of 0 to 100, with higher scores indicating more liking, with a Cronbach's alpha of .93.

Emotions. Participants' emotions toward Debbie were measured with the same instrument used in Studies 1 and 2: anger, sympathy, fear, and sadness. The respective Cronbach's alpha values were .88, .88, .76, and .57.

Factual inferences. Participants were then asked to draw inferences from 13 ambiguous factual issues that were present in the case. Some of the items tended to indicate that Debbie did in fact cheat on the exam (guilt facts). For example, recall that Debbie was seen crouching over her notes during most of the exam. The crouching was interpreted by the proctor as an attempt to conceal the notes, but Debbie insisted that she crouches because of a back injury sustained from playing on the volleyball team. Thus, one of the fact questions asked participants to state their agreement with the following statement: "The fact that Debbie crouched over her papers during the exam indicates that she was hiding something." Other measures asked for participants' agreement with statements that suggested that she did not cheat (innocence facts). For example, having being told that this was Ms. Simmons's first proctoring assignment with the university, participants were asked to state their agreement with "Ms. Simmons was motivated to catch someone cheating on her first day on the job."[5]

Manipulation questions. At the end of the study, participants were administered a manipulation check asking about what occurred in Debbie's life a few months prior to the cheating incident. Participants assigned to the sympathy condition were expected to check off the response "Debbie's brother Dylan was killed by a car."[6] Participants in this condition were given two additional follow-up items to facilitate the interpretation of the manipulation effect: participants were asked "Regardless of whether you think that Debbie cheated or did not cheat, would you describe the death of her brother as a tragic event in Debbie's life?" and "In principle, do you think that experiencing a tragic event has an effect on the likelihood of cheating on a college exam?" The latter question was intended to probe whether participants might endorse a belief that the death of Debbie's brother made her more likely to cheat, which would lead them to decide the case based on a behavioral inference about her conduct rather than through their own emotional reaction to her plight.[7]

Demographics. Finally, participants responded to demographic questions, including gender, age, and educational experience.

Results

The data included 394 participants, after removing 48 participants who did not complete the study within the designated time frame

[5] Like Study 2, studies 3 and 4 also included a pretest–posttest comparison of participants' background beliefs relating to the inferences involved in the case. For example, participants were asked to state their agreement with statements such as "In general, people who have lower back pain tend to crouch when they sit for extended periods of time." Another item asked for agreement with the statement, "In general, college professors are quite gullible." Replicating the findings from Study 2 and Simon, Snow, et al. (2004b), a comparison between the ratings given on the pretest and posttest revealed significant coherence shifts in the background beliefs. Because of space considerations, these measures and results will not be discussed further.

[6] Fifteen participants failed to respond correctly to this question. Nonetheless, we included these participants in the analysis. Excluding these subjects did not change the results.

[7] The manipulation follow-up items were inserted in anticipation that the manipulation could affect participants' judgments of the case through one of two different routes, both of which would display the coherence effect but lead to different results. First, consistent with our central hypothesis, the tragic information would arouse sympathy toward Debbie, which would trigger a concordant state of coherence by increasing the propensity to acquit her (which would, in turn, result also in more innocence-related interpretations of the ambiguous facts and in concordant hot cognitions: higher valence toward an acquittal, stronger motivation to see her win the case, stronger liking of her, and less anger toward her). Alternatively, we suspected, the tragic event might lead other participants to a different mental model of the case, driven by the belief that people who experience a personal tragedy are more likely to cheat. This behavioral prediction would naturally lead to higher rates of convicting Debbie and, consistent with the coherence effect, also to other judgments that cohere with that decision (more guilt-related interpretations of the ambiguous facts, as well as higher valence toward a conviction, stronger motivation to see her lose the case, less liking and more anger toward her).

(between 13 min and 1 hr), and 47 for their response to the manipulation follow-up items.[8]

The primary objective of this study was to test the effects of the sympathy manipulation. A one-way ANOVA of the between-subjects experimental manipulation was performed on the "sympathy for Debbie" and "anger toward Debbie" composites. As expected, those in the treatment condition reported a higher degree of sympathy for Debbie ($M = 4.46$, $SD = 1.60$) than those in the control condition ($M = 4.11$, $SD = 1.70$), $F(1, 392) = 4.44$, $p = .04$, $\eta^2 = .01$. Participants in the treatment condition also reported lower anger toward her ($M = 2.07$, $SD = 1.34$) than those in the control condition ($M = 2.51$, $SD = 1.53$), $F(1, 392) = 9.05$, $p < .01$, $\eta^2 = .02$.

As predicted, the manipulation influenced the verdict choices. Participants assigned to the treatment condition were less likely to decide that she cheated (29.8%) compared with those in the control condition (48.1%), $\chi^2(1, N = 394) = 13.75$, $p < .001$. By the same token, the mean likelihood of guilt estimations was lower in the treatment condition than in the control condition (38.1% v. 50.9%), $F(1, 392) = 17.45$ $p < .001$.

Coherence-based reasoning would predict that the manipulation will trigger concordant shifts throughout all dimensions of the task. Table 5 presents the effect of the manipulation on the participants' reaction to the various facets of the case. As predicted, all the variables shifted toward a state of coherence in line with the emotion manipulation. Importantly, the manipulation influenced both the cold cognition variables and the other hot cognition variables: valence, motivation, and liking, but not fear or sadness. Table 6 shows the correlation matrix for the condition (treatment v. control), the cold cognitions, and the hot cognitions. Consistent with the coherence hypothesis, correlations among all dependent variables were highly significant ($p < .001$, two-tailed; correlations with the condition variable were mostly significant at the level of $p < .01$).

Computer Simulation of Coherence-Based Reasoning

Given our theoretical contention that coherence-based reasoning operates on the basis of parallel constraint satisfaction processes, it would be helpful to show that coherence effects can be simulated in a computational model of constraint satisfaction processing. Related work (e.g., Spellman, Ullman, & Holyoak, 1993) has used the Co3 program (Coherence Model of Cognitive Consistency), which derives from Thagard's (1989) ECHO model of explanatory coherence. Similar programs have been used for other simulation purposes (e.g., Kunda & Thagard, 1996; Shultz & Lepper, 1996). Here, we use a standard constraint satisfaction program as implemented in the conditional stimulus (CS) module of O'Reilly's *emergent* neural network modeling program (Aisa, Mingus, & O'Reilly, 2008).

The purpose of these simulations was to demonstrate the plausibility of constraint satisfaction processes as a model of coherence-based reasoning. Thus, we simulated the coherence processes for a single hypothetical reasoner. In these simulations, we are focusing only on how the network settles at an equilibrium of satisfied constraints, not on the processes by which the network might be constructed. However, the CS module does implement learning, and if desired, one could model how connections are modified as a result of the evaluation process.

In this kind of constraint satisfaction model, cognitive elements that are consistent—that is, which support the same conclusion—activate one another through positive bidirectional links, whereas elements that are inconsistent or which support the opposite conclusion inhibit one another through negative bidirectional links. As shown in Figure 3, at the center of this model are the two conclusory nodes Cheated and Did Not Cheat. Because of their contradictory nature, these nodes are interconnected through a negative, inhibitory link. The factual sets consist of three facts that support Debbie's guilt ("Guilt Facts") and three that support a conclusion of innocence ("Innocence Facts"). Naturally, the Guilt Facts and the Innocence Facts are interconnected through bidirectional inhibitory links. The Innocence Facts are positively connected to the Did Not Cheat node, and the Guilt Facts are positively connected to the Cheated node. The three pairs of hot cognitions are connected to the conclusory nodes, so that positive valence toward Debbie prevailing (+Valence), Liking, and Sympathy are all positively connected to Did Not Cheat. By the same token, negative valence (–Valence), Disliking, and Anger are all positively connected to Cheated. The three opposing values of valence, liking, and emotion are interconnected through inhibitory links. Because motivation was measured by means of a single bipolar measure, the motivation unit is connected to both conclusory nodes, with one link being positive and the other negative, depending on the emerging resolution of the network. In these simulations, all positive links are set to .1 and all negative links are set to −.18.

Figure 3 depicts a model of the Debbie decision in the sympathy condition. The external activation of the model is provided by the Special unit, which provides activation to the environmental inputs: the six nodes representing the facts of the case and the manipulated node that is designed to induce feelings of sympathy (Brother Killed). Activation flows from the environmental inputs to all the nodes connected to them, and through them to all the other elements in the network. This design reflects the prediction that the manipulation will increase the sympathy toward Debbie, which will increase the likelihood to conclude that she was innocent. The heightened activation of the Did Not Cheat node is deemed to spread to all the other nodes that are positively connected to it, including the three Innocence Fact nodes and the three other hot cognitions: Positive Valence, Motivation to see Debbie Win, and Liking of her. In addition, because of the negative link

[8] Four participants responded negatively to the first manipulation follow-up, and 43 participants responded positively to the second question, all of whom chose the response, "Yes, experiencing a tragic event makes one more likely to cheat on an exam." We have excluded this group of 47 participants from the primary analysis. This exclusion seems justified by the fact that their mental model of human behavior is fundamentally different from the other participants in that condition. Indeed, the results show that even though both groups demonstrate strong coherence effects, they reached very different judgments of Debbie's guilt. The group of 47 participants reported greater sympathy toward Debbie than the other participants in the sympathy condition ($M = 5.04$ v. $M = 4.46$, $F[1, 233] = 5.37$, $p = .02$), but they convicted Debbie at more than twice the rate (61.7% v. 29.8%; $\chi^2[1, N = 235] = 16.59$, $p < .001$). The group of 47 participants also indicated significantly higher ratings of likelihood of guilt, $F(1, 233) = 17.67$, $p < .001$, posttest factual guilt ratings, $F(1, 233) = 13.94$, $p < .001$, valence, $F(1, 233) = 5.51$, $p = .02$, motivation, $F(1, 233) = 3.46$, $p = .06$, and anger, $F(1, 233) = 9.94$, $p < .01$. The groups differed also in levels of fear, $F(1, 233) = 9.33$, $p < .01$, and sadness, $F(1, 233) = 6.56$, $p = .01$. The group of 47 participants was marginally more inclined to convict even than the control condition (61.7% v. 48.1; $\chi^2[N = 253] = 2.85$, $p = .09$). It is important to note that including the group of 47 participants in the analysis does not change the results, except that one variable (posttest guilt facts) becomes nonsignificant.

Table 5
Dependent Measures Grouped by Condition (Study 3)

	Control condition (n = 206)	Tragic-information condition (n = 188)		
	Frequency	Frequency	χ^2	
Cold cognitions				
Decision (Debbie cheated)	48.1%	29.8%	13.75***	
	Mean (*SD*)	Mean (*SD*)	*F*	η^2
Likelihood of cheating	50.89 (31.57)	38.07 (29.10)	17.45***	.04
Guilt facts	−1.74 (1.96)	−2.23 (1.79)	6.57*	.02
Innocence facts	.06 (2.16)	.84 (2.03)	13.83***	.03
Hot cognitions				
Valence (Debbie disciplined)	5.26 (2.32)	4.63 (2.26)	7.37**	.02
Motivation (university win)	4.96 (2.77)	4.32 (2.65)	7.05**	.02
Liking Debbie	−.13 (.96)	.14 (.96)	7.85*	.02
Anger toward Debbie	2.51 (1.53)	2.07 (1.34)	9.05**	.02
Sympathy toward Debbie	4.11 (1.70)	4.46 (1.60)	4.43*	.01
Fear of Debbie	1.58 (1.10)	1.42 (.90)	2.48	.01
Sadness toward Debbie	3.26 (1.59)	3.38 (1.46)	.58	.001

* $p < .05$. ** $p < .01$. *** $p < .001$.

between the conclusory nodes, increased activation of the Did Not Cheat node will inhibit the activation of the Cheated node, which will decrease the activation of all the nodes that are positively linked to it. Over time, the nodes continue to pass positive and negative activation back and forth, until the network settles at a steady state in which the activation of the different elements ceases to change.

Figure 3 depicts the activation at this point. The network has reached its maximal level of coherence given the constraints specified by the initial activation of the elements and the links that interconnect them. This ultimate state of coherence strongly resembles the experimental data obtained from participants. Relative to the control condition simulation, in the sympathy simulation we observe higher activation of the Innocence facts and lower activation of the Guilt facts, greater activation of the Sympathy, Positive Valence, Liking, Motivation to see Debbie win, and Did Not Cheat nodes. We also observe lower activations of the Anger, Negative Valence, Disliking, and Cheated nodes.

To test the degree of resemblance between the simulation and our experimental results, we correlated the pattern of experimental data and the pattern of node activations in the simulation. Specifically, we calculated the difference between the control and sympathy conditions for each of the relevant dependent variables and then correlated those difference scores with the differences between the control and sympathy simulations in the activation of the corresponding nodes. First, we calculated the difference between the experimental results in the control condition and the sympathy condition for each of the following dependent variables: likelihood of cheating, agreement with guilt facts, agreement with innocence facts, valence (compounded and reverse coded so that positive values indicate positive valence toward the university winning), motivation (high values indicate motivation to see the university win), liking of Debbie, anger toward Debbie, and sympathy toward Debbie. Second, we calculated the difference between the node activations of the same variables in the sympathy and the control simulations.[9] Overall, we found a correlation of .68 between the experimental results and the activations of the corresponding nodes in the simulations.

Discussion

The findings of Study 3 offer further empirical support for our core hypothesis. Coherence spread from a manipulation of emotion that was wholly unrelated to the incident throughout all cold cognitive judgments of the incident and all other hot cognitive reactions to it. The computer simulation showed that the spread of coherence can be captured by a constraint satisfaction processing model. The activation of sympathy toward Debbie triggered a coherence effect throughout the hot and cold nodes, which was consistent with the experimental results. This provides further support for the plausibility of constraint satisfaction processes as the mechanism underlying the coherence effect.

Study 4 was intended to replicate and extend the findings from the previous two studies by applying a different manipulation. In this study, we manipulate participants' motivation toward the eventual outcome of the case of Debbie Miller, and predict that it will result in similar coherence effects as observed in Study 3.

[9] To calculate the activation in the simulations for likelihood of cheating, valence, and liking of Debbie we had to take an additional step, as these variables are each represented by two competing nodes. Thus, in order to calculate an overall measure of these variables we calculated the difference between the two relevant nodes: the Cheated node and the Did Not Cheat node, between the Positive Valence node and the Negative Valence node (with high values indicating positive valence toward seeing her get punished), and between the Liking node and the Disliking node. For each of these difference scores we then calculated the difference between the sympathy and control simulations.

Table 6
Intercorrelations Among Key Measures (Study 3)

	1	2	3	4	5	6	7
1. Condition							
2. Likelihood of cheating	.21***						
3. Guilt facts	.13*	.60***					
4. Innocence facts	−.19***	−.68***	−.42***				
5. Valence (Debbie disciplined)	.14**	.62***	.55***	−.62***			
6. Motivation (university win)	.13**	.65***	.55***	−.61***	.75***		
7. Liking toward Debbie	−.14**	−.33***	−.35***	.41***	−.40***	−.45***	
8. Anger/Sympathy toward Debbie	.17**	.53***	.56***	−.54***	.63***	−.64***	.61***

* $p < .05$. ** $p < .01$. *** $p < .001$.

Study 4

Method

Participants. Participants were 490 individuals who participated via the Internet. The sample was 52.5% female and 47.5% male. Participants' age ranged from 19 to 88 ($M = 50.15$, $SD = 13.50$). Of the sample, 82.8% reported having some post-high-school education, with a median of 3 years of post-high-school education.

Design. This study used the same basic set of materials as used in Study 3, in which participants were asked to determine whether Debbie Miller committed academic misconduct. The main purpose of the study was to test the effect of manipulating the participants' motivation toward the outcome of the case they were to decide. As in Study 3, we designed the manipulation to be as orthogonal as possible to the particular facts of the alleged cheating. The manipulation was performed by assigning participants to one of three conditions, each providing different context information regarding the handling of academic misconduct on campus prior to the participants' assignment to the role of Judicial Officer. In the condition that was designed to sway participants to conclude that Debbie did not cheat (the "pro-Debbie" condition), they were told that until recently, the university had been overzealous in pursuing students for possible cheating and thus had hurt some innocent students. In the condition that was designed to sway participants to conclude

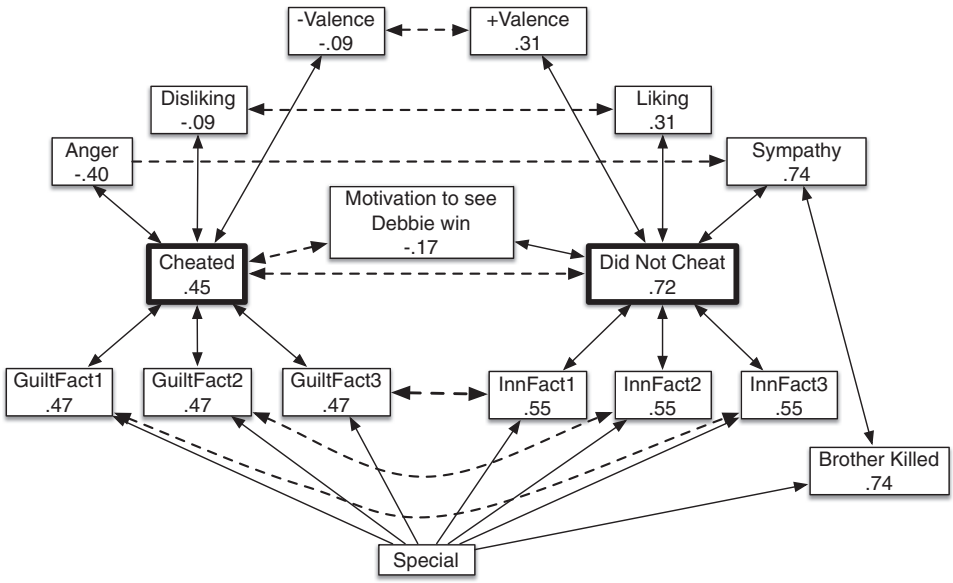

Figure 3. Network of the coherence simulation in Study 3 for the brother-killed manipulation (the sympathy condition). Each node represents a different concept in participants' model of the task and corresponds to a measured dependent variable, with the exception of the Special node and the Brother Killed node (which corresponds to the manipulation). The Special node provides starting activations for the facts and the manipulation. The number in the node represents its activation once the network has "settled" or reached maximal coherence. Excitatory links are represented by solid lines and inhibitory links by dashed lines. All excitatory weights are .1 and all inhibitory links are −.18. Double-headed arrows represent bidirectional connections with bidirectional spread of activations. Single-headed arrows represent spread of activation only in the direction of the arrowhead.

that Debbie did cheat (the pro-University condition), participants were told that students who previously cheated on exams had benefited at the expense of honest students, and that the cheating was harming the university's reputation and its relationships with its alumni. In the neutral condition, participants were given mixed information. The intuition behind these manipulations was that in deciding Debbie Miller's case, participants would try to correct for past wrongs and thus feel motivated to decide the case in accordance with their assignment.

Materials and procedures. Participants were recruited in the same manner as in the previous studies. Participants first read the consent form and then completed the study online by clicking through a series of web pages that contained the instructions, the case information, and the measures (because of a technical glitch with the liking-thermometer measure, liking was measured only using an 11-point scale). Except for the respective manipulations, the materials were highly similar to the materials used in Study 3.

The manipulation was administered immediately after the presentation of the background information about the case but before participants received any information about the particular facts of the incident. Participants were randomly assigned to one of three conditions: pro-Debbie, neutral, and pro-University (for the full text used in the manipulations, see the Appendix). Following the introductory instructions, participants were tested for their memory of the manipulation.[10] At the conclusion of the study, participants were thanked for their participation.

Results

The data included 423 participants. Data were not analyzed for the 67 participants who did not complete the study within the designated timeframe (between 13 min and 1 hr).

The primary objective of this study was to test the effects of the motivation manipulation. One-way ANOVAs of the motivation experimental manipulation were performed on both the hot- and cold-cognition variables. Because we predicted a linear change from the pro-Debbie condition to the pro-University condition, we report the significance of the linear trend. Bonferroni adjusted comparisons between the conditions are reported in Table 7.

Participants were more motivated to see the university win in the pro-University condition ($M = 6.02$, $SD = 2.93$) than in the pro-Debbie ($M = 4.78$, $SD = 2.50$) and neutral ($M = 4.89$, $SD = 2.33$) conditions, $F(1, 419) = 13.16$, $p < .001$, $\eta^2 = .03$. However, the pro-Debbie and neutral conditions did not differ from one another. Thus, it appears that although the pro-University manipulation was effective in producing the intended effect, the pro-Debbie manipulation was largely ineffective. Hence, we expect to find coherence effects in all conditions, but the effects of the manipulation only when comparing the pro-University condition with the other two conditions. In our judgment, given that the manipulations altered just one factor in a complex and multidetermined task, the failure of one of the manipulations should not come as a great surprise.

Consistent with the prediction from coherence-based reasoning, the array of measures in the pro-University condition are almost uniformly different from the pro-Debbie condition and the neutral condition. As shown in Table 7, participants assigned to the pro-Debbie condition were less likely to decide that she cheated (38.7%) compared with those in the neutral condition (43.2%) and the pro-University condition (59.4%), $\chi^2(2, N = 423) = 12.94$, $p = .002$. Judgments of the likelihood of Debbie's guilt followed a similar pattern, with rates in the pro-university condition ($M = 57.87$, $SD = 32.56$) significantly higher than the pro-Debbie condition ($M = 44.62$, $SD = 30.42$) and marginally higher ($p = .06$) than the neutral condition ($M = 48.85$, $SD = 32.31$), $F(1, 407) = 11.60$, $p = .001$, $\eta^2 = .03$.

Similar effects can be observed throughout the other dimensions of the task. The key variables in the pro-University condition are more consistent with judgments of guilt than in the two other conditions, though the liking and sympathy measures fell short of statistical significance. As predicted, and as observed in Study 3, no differences are found in the measures of fear and sadness.

As shown in Table 8, the correlation matrix for the main variables confirmed widespread coherence among the condition (pro-Debbie condition vs. neutral vs. pro-University condition), the cold cognitions, and the hot cognitions.

Computer Simulation of Coherence-Based Reasoning

To confirm that coherence effects can be simulated in a computational model of constraint satisfaction processing, we simulated the pro-Debbie and pro-University conditions using the CS module from *emergent*. Figure 4 captures a model of the pro-University condition. The model we ran was very similar to the model shown in Study 3, except for the different manipulations. As seen in Figure 4, the external activation of the model is provided by the Special unit, which provides activation to the six nodes representing the facts of the case, and in the treatment condition, also to the manipulated background situation on campus regarding cheating (specifically, the fact that "cheaters prosper"). Activation flows from the environmental inputs to all the nodes connected to them, and through them to all the other elements in the network. This design reflects the prediction that the manipulation will increase the motivation to see the university win the case, which will increase the likelihood to conclude that she did in fact cheat. The heightened activation of the Cheated node is deemed to spread to all the other nodes that are positively connected to it, including the three Guilt Fact nodes and the three other hot cognitions: Negative Valence, Anger toward Debbie, and Disliking of Debbie. In addition, because of the negative link between the conclusory nodes, increased activation of the Cheated node will inhibit the activation of the Did Not Cheat node, which will decrease the activation of all the nodes that are positively linked to it. Over time, the nodes continue to pass positive and negative activation back and forth, until the network settles at a steady state in which the activation of the different elements ceases to change.

Figure 4 depicts the activation at this point. The network has reached its maximal level of coherence given the constraints specified by the initial activation of the elements and the links that interconnect them. This ultimate state of coherence resembles the experimental data obtained from participants who engaged in this task. Relative to the pro-Debbie condition simulation, in the pro-University simulation, we observe higher activation of the Guilt

[10] Fifty participants failed to respond correctly to this question. Nonetheless, we included these participants in the analysis. Excluding these subjects did not change the results.

Table 7
Dependent Measures Grouped by Condition (Study 4)

	Pro-Debbie (n = 142)	Neutral (n = 148)	Pro-University (n = 133)		
	Frequency	Frequency	Frequency	χ^2	
Cold cognitions					
Decision (Debbie cheated)	38.7	43.2	59.4	12.94**	
	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	F (linear trend)	η^2
Likelihood of cheating	44.62 (30.42)[a]	48.85 (32.31)[a]	57.87 (32.56)*[b]	$F(1, 407) = 11.60$, $p = .001$	.03
Guilt facts	−1.44 (1.42)[a]	−1.27 (1.61)[ab]	−.90 (1.67)[bc]	$F(1, 420) = 8.16$, $p = .004$	.02
Innocence facts	.76 (1.42)[a]	.56 (1.53)[ab]	.27 (1.72)[bc]	$F(1, 420) = 7.00$, $p = .008$	.02
Hot cognitions					
Valence (Debbie disciplined)	3.90 (1.49)[a]	4.02 (1.67)[a]	4.76 (1.96)[b]	$F(1, 420) = 17.26$, $p < .001$	.04
Motivation (university win)	4.89 (2.33)[a]	4.78 (2.50)[a]	6.02 (2.93)[b]	$F(1, 419) = 13.16$, $p < .001$	.03
Liking Debbie	6.74 (1.43)[a]	6.75 (1.56)[a]	6.40 (1.50)[a]	$F(1, 418) = 3.56$, $p = .06$	.01
Anger toward Debbie	2.17 (1.38)[a]	2.35 (1.46)[a]	2.83 (1.60)[b]	$F(1, 420) = 13.53$, $p < .001$	.03
Sympathy toward Debbie	3.95 (1.68)[a]	3.93 (1.54)[a]	3.74 (1.52)[a]	$F(1, 420) = 1.24$, $p = .27$	.003
Fear of Debbie	1.61 (1.07)[a]	1.67 (1.04)[a]	1.61 (1.25)[a]	$F(1, 420) = .01$, $p = .99$	.000
Sadness toward Debbie	2.81 (1.49)[a]	3.01 (1.45)[a]	3.01 (1.69)[a]	$F(1, 420) = 1.21$, $p = .27$	.003

Note. Means that do not share a common subscript are significantly different at $p < .05$, Bonferroni adjusted comparison. The asterisk (*) indicates a marginal significance ($p = .06$) between the pro-University condition and neutral condition for likelihood of cheating.

facts and lower activation of the Innocence facts, and higher activations of the Anger, Negative Valence, Disliking, and Cheated nodes. We also observe lower activation of the Sympathy, Positive Valence, Liking, Motivation to see Debbie win, and Did Not Cheat nodes.

To test the degree of resemblance between the simulation and our experimental results, we correlated the pattern of experimental data and the simulation activations in the same manner as conducted in Study 3. Overall, we found a correlation of .86 between the experimental results and the activations of the corresponding nodes in the simulations.

Discussion

Study 4 replicated and extended the studies that came before it. Replicating Study 3, we found that a manipulation of a hot cognition that was orthogonal to Debbie's conduct triggered a coherence effect that spread across an entire task and swayed factual inferences that could not be plausibly related to the manipulation. The manipulation also swept along with it, other hot cognitions, namely, valence and anger.

The computer simulation showed that the spread of coherence can be captured by a constraint satisfaction processing model. The activation of motivation to see the university win triggered a coherence effect throughout the hot and cold cognitions, which was consistent with the experimental results. This provides support for the plausibility of constraint satisfaction processes as the mechanism underlying the coherence effect.

General Discussion

The current studies replicated the coherence effect observed in prior research (Glöckner et al., 2010; Glöckner & Engel, 2013a; Holyoak & Simon, 1999; Lundberg, 2007; Phillips, 2002; D. Simon, Krawczyk, et al., 2004; D. Simon, Snow, et al., 2004). Across all four studies, which included two new sets of materials, we found that coherence emerged between the factual interpretations and the judgment or decision reached. The novelty of these

Table 8
Intercorrelations Among Key Measures (Study 4)

	1	2	3	4	5	6	7
1. Condition							
2. Likelihood of cheating	.17***						
3. Guilt facts	.14**	.60***					
4. Innocence facts	−.13**	−.64***	−.39***				
5. Valence (Debbie disciplined)	.20***	.66***	.52***	−.56***			
6. Liking toward Debbie	−.09	−.22***	−.26***	.33***	−.32***		
7. Anger toward Debbie	.18***	.46***	.49***	−.33***	.47***	−.21***	
8. Motivation (university win)	.17***	.57***	.54***	−.54***	.69***	−.32***	.39***

* $p < .05$. ** $p < .01$. *** $p < .001$.

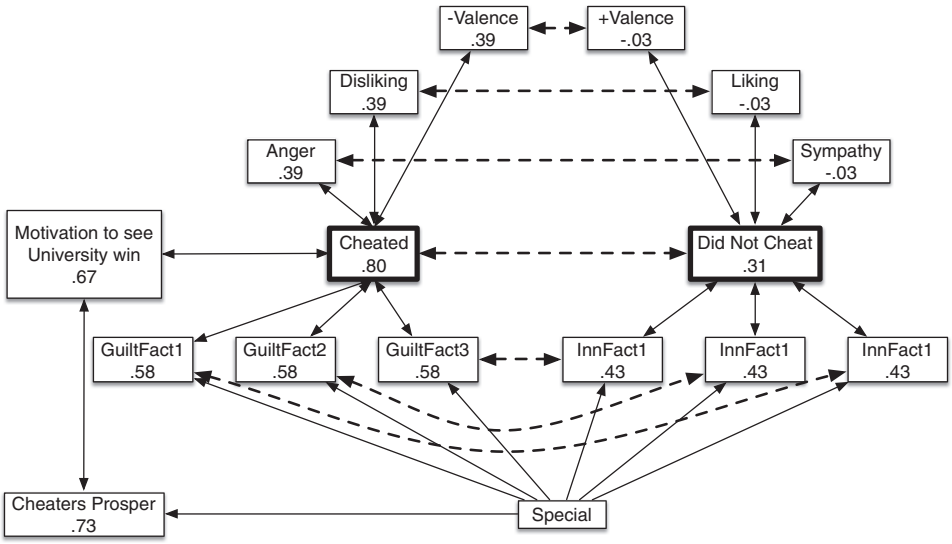

Figure 4. Network of the coherence simulation in Study 4 for the cheaters-prosper manipulation (the "pro-university" condition). Each node represents a different concept in participants' model of the task and corresponds to a measured dependent variable, with the exception of the Special node and the Motivation to see the University Win node (which corresponds to the manipulation). The Special node provides starting activations for the facts and the manipulation. The number in the node represents its activation once the network has "settled" or reached maximal coherence. Excitatory links are represented by solid lines and inhibitory links by dashed lines. All excitatory weights are .1 and all inhibitory links are −.18. Double-headed arrows represent bidirectional connections with bidirectional spread of activations. Single-headed arrows represent spread of activation only in the direction of the arrowhead.

studies lies in the extension of the coherence effect into the domain of "hot cognitions." Coherence was found to also encompass valence evaluations, motivation with respect to the eventual outcome of the situation, liking of the protagonists, and emotions toward the protagonists.

Study 1 entailed making a social judgment regarding the stability of a relationship between a couple, Jenny and Mark. Consistent with prior research, participants drew inferences from the ambiguous evidence that cohered with their judgments as to whether Jenny was actually committed to the relationship or was not. Importantly, we also found the predicted enmeshment of hot cognitions. Compared with participants who concluded that Jenny is committed to the relationship, those who concluded that she is not committed expressed more negative valence toward the prospect of the couple staying together and were more motivated to see them break up. These participants also liked Jenny less and felt more anger toward her, while feeling more sympathy and sadness toward Mark. Also as expected, the groups did not differ on feelings of fear toward either Jenny or Mark.

Studies 2, 3, and 4 introduced manipulations to provide a stronger causal test for our core hypothesis. The prediction from coherence-based reasoning and its underlying connectionist architecture is that a manipulation of any relevant facet of the task has the potential to shift all other facets—both cold and hot cognitions—toward greater coherence with the manipulated outcome. Consistent with prior research (e.g., Holyoak & Simon, 1999, Study 3; D. Simon, Krawczyk, et al., 2004, Study 1; D. Simon, Snow, et al., 2004, Study 4), Study 2 found that strengthening one piece of evidence in the criminal prosecution of Jason Wells resulted in higher estimations of his guilt and in elevated conviction rates. This manipulation also drove concordant interpretations of the other pieces of evidence toward a stronger indication of guilt. The novelty of this study lies in the effect of the manipulation on the hot cognitions. Altering the strength of the evidence against Jason swept through the hot cognitions pertaining to the case: more positive valence toward the prospect of a conviction, a stronger motivation to see Jason get convicted, greater disliking of him, and stronger anger and less sympathy toward him.

Employing an opposite treatment, Studies 3 and 4 demonstrated that the coherence effect can be driven also by manipulating hot cognitions. Study 3 employed an emotional manipulation to influence judgments of whether Debbie Miller cheated on a college exam. Informing participants of a tragic death in her family heightened sympathy and inhibited anger toward her, which resulted in lower judgments of her guilt and in more exculpatory inferences drawn from the ambiguous evidence. Importantly, the manipulation also spilled over into the other hot cognitions, resulting in more negative valence towards the prospect of seeing her disciplined, stronger motivation to see her win the case, and greater liking of her. Study 4 replicated these findings by manipulating the participants' motivation toward the eventual outcome of the case. Whereas the pro-Debbie manipulation yielded trends in the predicted directions that fell short of statistical significance, the pro-University manipulation yielded significantly stronger motivation to see the university win the case. Relative to the other participants, those assigned to the pro-University condition were also more likely to assign a high likelihood to the conclusion that Debbie cheated, to find her guilty of the alleged misconduct, and

to interpret the ambiguous evidence as indicative of her guilt. These participants also reported more positive valence toward the prospect of seeing Debbie get disciplined and felt greater anger toward her, though the prediction of less empathy was not borne out.

Studies 1 and 2 also contained a within-subject treatment that provided more direct evidence of the emergence of coherence. As predicted, participants responded differently to identical factual inferences when they were administered in the form of isolated vignettes (pretest) versus when they were embedded into a large case (posttest): There were no meaningful relationships among the pretest measures, but on the posttest, both the cold and hot measures were strongly intercorrelated, forming a coherent mental representation, regardless of whether the conclusion was arrived at spontaneously (Study 1) or via the experimental manipulation (Study 2).

In all, the widespread coherence observed in these studies captures the interconnectedness that lies at the core of the connectionist representation of the tasks and the constraint satisfaction mechanisms by which they are performed (see Holyoak & Thagard, 1989; McClelland & Rumelhart, 1986; Read & Simon, 2012; Read et al., 1997). This interconnectedness is evidenced clearly by the consistent intercorrelations among all the key facets of the tasks, as depicted in tables 2, 4, 6, and 8. It is also evidenced by the fact that the manipulations influenced variables to which they were not related in any plausible manner. Recall, for example, that the manipulation used in Study 3 introduced a fatal car accident that was unrelated to the alleged cheating incident that occurred months later in a remote exam room. Yet that tragedy influenced the host of inferences of what transpired in the classroom, making participants more inclined to believe that Debbie sat crouched during the exam not because she was hiding her notes but because of her chronic back pain, and that the proctor could not be trusted on her first day on the job. Notably, in Study 4, participants drew opposite inferences following a manipulation to decide in favor of the university. These influences are both far-flung and nonnormative. One would be hard pressed to propose any plausible explanation for these effects, other than that they are the product of parallel constraint satisfaction processes, driving the representation of the task toward a state of coherence.

It is important to acknowledge an inherent limitation of coherence-based reasoning. The coherence effect is very sensitive to the exact location of each element in the network or, in plain terms, to which elements *go with* which outcomes. Constraint satisfaction processing is a process model, and as such it has little to say about the manner in which the mental representations of the task are constructed in the first place. It only explains the processing of the task, given that representation. Representations are formed based on the particular person's understanding of the particular task, in the particular context. As stated by Phoebe Ellsworth (2013, p. 125), the associations are determined by whatever "it is about the situation that *matters*." Thus, for example in Study 1, if Jenny had been the victim of abuse by Mark, our participants might well have reacted to the couple in an opposite manner, applauding Jenny for not being committed to the relationship (rather than feeling angry toward her) and feeling anger (rather than sympathy) toward Mark. Likewise, if Jason Wells had killed a terrorist who was just about to unleash a weapon of mass destruction on a large city (rather than killing the security guard in his employer's office), finding him responsible for the homicide would likely result in heightened liking of him and a motivation to see him cleared of all charges (if not awarded a medal of honor). Because of the infinite range and variability of the human experience, it is well beyond the power of coherence-based reasoning—or of any other psychological framework, for that matter—to account for and predict the full gamut of associations that different people will make in any given situation. The value of the theory is in explaining the process by which the mental models will reach resolution given the complex, ambiguous, and conflicting associations that are inherent in the judgments and decisions that people face in everyday live.

Relation to Simulation Models, Appraisal Theory, and Other Research Programs

The extension of the coherence effect into the domain of hot cognitions provides empirical support for various simulation models that are based on constraint satisfaction processing. The findings are clearly consistent with Thagard's (2006) HOTCO model, which integrates likability and desirability of the decision options, Nerb's (2007) model that maximizes the coherence between and among the represented beliefs and desires (Nerb & Spada, 2001; Thagard & Nerb, 2002), as well as the neurally inspired appraisal model offered by Sander et al. (2005). Our findings also provide experimental support for Lewis's (2005) dynamic systems model that enmeshes cognitive processing with emotional arousal, action tendencies, and feelings. Notably, our studies are also consistent with neuroscience research, which provides evidence for the interactivity and integration of cognitive and emotional functioning (Pessoa, 2008; Pessoa & Pereira, 2013).

The current findings are consistent with the core features of cognitive appraisal theories of emotion (Ellsworth & Scherer, 2003; Frijda, 1986; Lazarus, 1966; Roseman & Smith, 2001). In all studies, we found a close correspondence between the emotions that arose and the cold cognitive judgments and inferences that triggered them, that is, the cognitive appraisals. Given that all of our studies involved the prospect of some form of norm-violating behavior by the protagonists, the materials tended to arouse anger toward them (see Goldberg et al., 1999; Lerner et al., 1998; Ohbuchi et al., 2004). Yet as postulated by appraisal theories, different appraisals evinced differentiated emotions, including sympathy and in one case also sadness, but not fear (which was not expected to be aroused). The opposite emotions expressed toward Jenny (anger) and Mark (sympathy) in Study 1 are further evidence that our studies captured concrete emotions that corresponded closely to the cognitive appraisal of the protagonists and their deeds. Our findings are most closely aligned with variants of appraisal theory that posit a dynamic and bidirectional interaction between cognitive appraisal and emotional arousal (Frijda, 1993; Keltner et al., 1993; Roseman & Smith, 2001; Scherer, 1984, 2001), and with those that highlight the features of synchronicity among the appraisal components (Scherer, 2009) and componential coherence (Roseman, 2011).

Our findings also have strong parallels with a host of influential experimental research programs that interrelate cold and hot cognitions. Notably, social psychologists have observed that social judgment is susceptible to the influence of emotion (Goldberg et al., 1999; Keltner et al., 1993; Lerner et al., 1998; Ohbuchi et al.,

2004), and that reasoning can be swayed by motivation (Brownstein et al., 2004; Ditto et al., 2003; Kahan et al., 2011, 2012; Munro et al., 2002; and Wyer & Frey, 1983; for a review, see Kunda, 1990). Similarly, a large body of research in the field of judgment and decision making has demonstrated the ways in which emotions interact with decision making (Lerner et al., 2004; Loewenstein & Lerner, 2003; Slovic et al., 2002),

However, as noted earlier, these important and familiar findings tend to suffer from one or more of four shortcomings: being limited to an interaction between a singular cold cognition and a singular hot cognition; being limited to unidirectional effects (demonstrating an effect from one type of cognition to another, but not both effects in both directions); focusing only on global judgments, decisions, and propositions, without examining their interaction with the underlying facts from which they are inferred; crucially, for the most part, these findings also lack a theoretical explanation. To the best of our knowledge, no general theoretical framework has been offered to explain these vital theories, which leaves them in an insular and underdeveloped state.

It is possible that the first three shortcomings could somehow be overcome by cobbling together a patchwork of findings from numerous separate research programs, though they are best addressed by means of a singular, unified, and parsimonious theory (Popper, 1961; H. A. Simon, 2002). Naturally, the best solution to the lack of a general theoretical framework is to offer one. We propose that coherence-based reasoning and its underlying constraint satisfaction processing provide a suitable framework for all four shortcomings. As demonstrated by the current studies, the coherence effect encompasses a wide range of both cold and hot cognitions, it captures their bidirectional relationships, and it interrelates global judgments with the factual inferences on which they rely. The suitability of constraint satisfaction processing is manifested by its successful application to a wide variety of cognitive processing—ranging from low-level processing, such as vision (McClelland & Rumelhart, 1986; Rumelhart & McClelland, 1986), through text comprehension (Kintsch, 1988) and social reasoning (Read & Miller, 1998), to high-level reasoning (Holyoak & Simon, 1999; Holyoak & Thagard, 1989; Thagard, 2000).

Distinction From Other Cognitive Consistency Theories

Coherence-based reasoning shares its theoretical underpinnings with an array of cognitive consistency theories both old (Abelson et al., 1968; Festinger, 1957; Heider, 1946, 1958; McGuire, 1968; Newcomb, 1968) and new (Gawronski, 2012; Gawronski & Strack, 2012; Harmon-Jones, Amodio, & Harmon-Jones, 2009; Harmon-Jones, Harmon-Jones, & Amodio, 2012; Kenworthy, Miller, Collins, Read, & Earleywine, 2011). As such, our approach does not challenge any of those kindred theories, but it is, in our opinion, appreciably distinct from them. Notably, coherence-based reasoning applies to a considerably wider range of tasks and operates with greater flexibility than its sibling theories.

For one, the coherence framework is not limited to dyadic and triadic structures postulated by classic consistency theories (Festinger, 1957; Heider, 1946, 1958; but cf. Abelson & Rosenberg, 1958). Recall that in the current studies, coherence swept through entire task representations, reaching every one of the numerous factual inferences, judgments, and hot cognitions. Thus, our findings demonstrate that coherence can spread and drive changes throughout sizable networks.

Second, coherence-based reasoning is not confined to elements that are necessarily "obverse" to one another, as postulated by cognitive dissonance theory and its progeny. According to Festinger (1957), "*x* and *y* are dissonant if not-*x* follows from *y*" (p. 13), such as when a person stands in the rain but does not get wet. Following Festinger, Gawronski (2012) operationalizes dissonance by means of logical contradictions between propositional beliefs (such as "I am a good student," and "I got a low mark on the essay"). The propositions must be such that they can be regarded as either true or false by the individual (Gawronski & Strack, 2004), which precludes nuanced relations based on the semantic meaning of cognitive concepts (Gawronski, 2012). Coherence-based reasoning is not confined to formal propositional contradictions. As such, our approach provides a better fit with real life reasoning tasks, in which attributes rarely contradict one another outright. More typically, attributes exist in some degree of tension with one another, and in many cases they do not conflict directly but merely happen to *go with* different outcomes. Thus, the connections represented in constraint satisfaction models are conceived as weighted links of varying strength that serve as "soft constraints" (Holyoak & Thagard, 1997), and which inevitably afford some room for cognitive slack (Holyoak & Thagard, 1997; see also Katz, 1968; McGuire, 1968). This flexibility enables constraint satisfaction processes to capture the ubiquitous informal and pragmatic implications that flow from the semantically rich mental tasks of everyday life.

Third, the conditions for triggering the coherence effect are minimalistic. As demonstrated by the social judgment task in Study 1 and by the findings of D. Simon et al. (2001), coherence can be precipitated by the mere epistemological need of making sense of one's environment (see also Higgins, 2012; Kruglanski & Shteynberg, 2012). Thus, in contrast to the cognitive dissonance theory tradition, coherence does not require the perpetration of an immoral conduct (Festinger & Carlsmith, 1959), a violation of an important aspect of one's self-concept (Aronson, 1968, 1992; Steele, Spencer, & Lynch, 1993), a strong need to rationalize and justify one's deeds (Beauvois & Joule, 1996, 1999), or the causing of irreparable harm (see Cooper & Fazio, 1984). To be sure, these conditions can readily serve as moderating variables that intensify the coherence effect, but they are not necessary for its emergence.

Fourth, in the context of decision making, the coherence effect is not reduced to a postdecisional phenomenon, as postulated by cognitive dissonance theory (Brehm, 1956; Festinger, 1957), nor is it conditioned on the making of a commitment to a decision (Brehm & Cohen, 1962; Festinger, 1964) or on the emergence of a postdecisional conflict between competing action implementations (Harmon-Jones et al., 2009, 2012). Rather, the research on the coherence effect has shown that the spreading apart occurs for the most part predecisionally (Holyoak & Simon, 1999; D. Simon, Krawczyk, et al., 2004; D. Simon et al., 2001), a notion that is compatible with a host of findings of predecisional distortion from the field of Judgment and Decision Making (DeKay et al., 2012, 2014; Janis & Mann, 1977; Montgomery & Willen, 1999; Russo et al., 1998, 2008; Svenson, 1999; for reviews, see Brownstein, 2003; Russo, 2014). The findings from Study 1 provide further support for this proposition. Recall that Study 1 involved making a social judgment (evaluating Jenny's commitment to her relationship with

Mark). As such, there was no decision to be made in this task. Yet in making that nondecisional judgment, our participants demonstrated the usual coherence effect, spreading the variables apart to support their respective conclusion (for related findings, see D. Simon et al., 2001, Studies 2 and 3). The fact that this spreading apart was observed in the absence of any decision is clear proof that coherence cannot be characterized as an exclusive feature of postdecisional processing, and it cannot be said to be contingent on commitments or postdecisional action implementation conflicts (cf. Brehm & Cohen, 1962; Harmon-Jones et al., 2009, 2012). Rather, the coherence effect is best understood as an adaptive mechanism that enables confident choice and action (see also DeKay et al., 2012, 2014; Janis & Mann, 1977; Montgomery & Willen, 1999; Russo et al., 1998, 2008; Svenson, 1999). We agree with Bruner (1957) and Abelson (1983) that to gain meaningful insight into human decision making, we ought to focus on the processes that lead to the making of decisions, rather than on the ex post facto means of rationalizing and justifying decisions already made (see also McGuire, 1968).

In sum, coherence-based reasoning seems unique among cognitive consistency theories in its ability to handle large and semantically rich tasks and to address both soft and hard constraints, in the minimal conditions required for its activation, and in its application to both pre- and postdecisional phases of the process. The current studies enhance its scope by demonstrating its ability to incorporate and harmonize between and among cold and hot cognitions. Thus these studies bring us closer to realizing the aspirations of Abelson (1983), McGuire (1968), and Newcomb (1968) to provide a general framework of cognitive functioning that enables the comprehension and engagement with the complex environments within which we live.

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Appendix

Excerpts From Materials That Were Used in the Manipulation of the Groups in Study 4

In the pro-Debbie condition, participants were told,

> When the Dean of Students notified you of your appointment to the position of Judicial Officer, she stated that the situation surrounding academic misconduct has recently become a very sensitive issue on campus. The Dean explained that there is considerable frustration with the university's conduct on this matter. Problems arose soon after the appointment of your predecessor, an alumnus of the university who was appointed straight out of a senior position in the Military Police Corps. During his tenure as Judicial Officer, there was a threefold jump in the number of students being prosecuted for academic misconduct, and an even greater increase in the number of students being disciplined. Student organizations have submitted a petition criticizing the university for its "overzealous prosecution and excessive punishment based on mere allegations of misconduct." The petition was signed also by a large number of teaching assistants and professors, including some of the university's most highly regarded faculty members. The student newspaper recently published three stories of students who were suspended for cheating, but were later found to have been innocent. The newspaper blamed the Department for Student Disciplinary Affairs for these mistakes. The Dean added that she believed that the newspaper's assessment was probably correct.

In the neutral condition, participants were told,

> When the Dean of Students notified you of your appointment to the position of Judicial Officer, she described the situation surrounding academic misconduct as "mixed." University officials have reported that a surge in cheating by students has brought many parents and alumni to express concern over the university's reputation. The Provost has stated that many people feel that the Department of Student Disciplinary Affairs is not pursuing the allegations seriously enough. At the same time, the student body has complained that the university has gone overboard in punishing students on the basis of flimsy evidence. A number of professors and teaching assistants signed a petition criticizing the university for "its zealous prosecution and excessive punishment for mere alleged misconduct."

In the pro-University condition, participants were told,

> When the Dean of Students notified you of your appointment to the position of Judicial Officer, she stated that the situation surrounding academic misconduct has recently become a very sensitive issue on campus. The Dean explained that there is considerable frustration with cheating by students. University officials have stated that cheating by students is creating a moral crisis that is harming the university's reputation in the academic community and is straining relationships with alumni. In a recent address to the students, the Provost emphasized the harm that cheaters inflict on the honest and hardworking students. The student newspaper recently published an investigative story about three students who cheated on exams without getting caught. All three went on to get lucrative job offers from companies that participated at an on-campus employment fair. The newspaper also interviewed three other well qualified students who came close to getting those job offers, but did not get them. One of these students stated "it is tough being honest. I feel very frustrated seeing a cheater get a great job offer that should have been mine." The newspaper blamed the Department of Student Disciplinary Affairs for the "corruption of academic integrity," and called for more vigorous investigations to prevent cheaters from prospering. The Dean added that she believed that the newspaper's assessment was probably correct.

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