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The Hindsight Bias: Judgment Task Differentiation

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THE HINDSIGHT BIAS: JUDGMENT TASK DIFFERENTIATION

by

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ABSTRACT

THE HINDSIGHT BIAS: JUDGMENT TASK DIFFERENTIATION

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Recent hindsight bias research suggests that modern Cognitive Reconstruction theories that model hindsight effects as non-unitary phenomena potentially confound their findings by not differentiating between judgment tasks. This experiment tests a non-unitary approach of modeling hindsight effects that predicts confidence ratings and outcome likelihood judgments to be independent tasks, governed by differing cognitive processes and susceptible to unique patterns of hindsight bias. Predictions specify that sense-making theories accurately account for hindsight bias effects for outcome likelihood ratings and expectation based adjustment models accurately account for “I would have known that!” hindsight bias effects for confidence ratings. Utilizing a within-subjects, narrative text paradigm, the proposed non-unitary approach was tested by investigating whether the effects of outcome congruency on hindsight bias results were moderated by the type of judgment task. Participants read stories, rated their confidence in predicting the outcome or the likelihood of possible outcomes, given either expected or unexpected story outcomes, and then asked to recall their ratings. Results supported the predictions of the proposed non-unitary approach with confidence ratings and outcome likelihood judgments producing opposite patterns of hindsight bias effects. Theoretical implications, study limitations and future research directions were also discussed.

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CHAPTER I

INTRODUCTION

In one of the earliest hindsight bias investigations, Fischhoff and Beyth (1975) had participants attempt to recall the beliefs they held in the past before receiving outcome feedback. First, participants judged the probability of different outcomes of Nixon's then upcoming political trips to Moscow and Peking. Then after the trips, the participants were told the political outcomes of the trips and were asked to recall the probabilities they had earlier assigned to the outcomes. Results revealed that remembered probabilities were biased in favor of the actual outcomes. In other words participants "remembered" having given higher probabilities to events that actually occurred and lower probabilities to events that did not occur, hence the "hindsight bias".

In the last 30 years, the "hindsight bias" has become one of the most frequently cited judgment biases. The bias began receiving attention when Fischhoff (1975) published his seminal hindsight paper and research has since lead to two meta-analytic reviews (Christensen-Szalanski & Willham, 1991; Guilbault, Bryant, Brockway & Posavac, 2004), five substantive theoretical reviews (Blank, Nestler, von Collani & Fischer, 2008; Erdfelder & Buchner, 1998; Hawkins & Hastie, 1990; Hoffrage & Pohl, 2003; Stahlberg & Maass, 1998) and two journal special issues (*Memory*, 2003; *Social Cognition*, 2007), revealing the bias to be robust across a wide variety of situations, domains, and task environments and influencing processes involved in learning, memory storage, memory retrieval, and judgment formation (Hawkins & Hastie, 1990). Furthermore, the appearance of this bias in many "real life" situations, such as stock purchases, jurors' decisions and medical diagnoses indicates that research into this

phenomenon has several practical implications (Christensen-Szalanski & Willham, 1991). Due to the ubiquity and real-world occurrence of this bias, the goal of proposing and evaluating theoretical explanations for the hindsight bias phenomenon is important for both scientific and applied purposes.

To date, *Cognitive Reconstruction* (CR) theories have provided the most plausible explanation of the hindsight bias (Christensen-Szalanski & Willham, 1991; Guilbault, Bryant, Brockway, & Posavac, 2004; Hawkins & Hastie, 1990, Stahlberg & Maass, 1998). CR theories claim that individuals do not directly access a memory of their predictive judgments when making retrospective judgments. Instead, individuals either rejudge the current situation or estimate the initial decision in an attempt to reconstruct the initial judgment. Therefore, CR theories propose that the exposure to outcome information influences the reconstruction process and leads the person to overestimate their predictive accuracy. In this context, the hindsight bias can be defined as the descriptive account of the systematic difference between people's predictive and retrospective judgments (Ash, 2009).

However, specific methodological concerns and empirical inconsistencies in the hindsight literature have lead to questions of the adequacy of CR theories to thoroughly and accurately model the hindsight bias. First, in attempting to explain the specific nature of the cognitive mechanism(s) responsible for eliciting hindsight, the literature reveals a host of competing CR theories that propose different types of judgment reconstruction mechanisms (Hawkins & Hastie, 1990). Second, research attempting to "de-bias" the hindsight bias based on these CR theories have lead to inconsistent results (Guilbault et

al., 2004). Lastly, the research attempting to predict individual differences based on these CR theories has been largely unsuccessful (Musch & Wagner, 2007).

These issues have raised fundamental questions concerning the cognitive mechanisms involved in retrospective judgment making and if the hindsight bias is a unitary phenomenon (Ash, 2009; Blank, Nestler, von Collani, & Fischer, 2008). It has been proposed that some of the opposing hindsight predictions made by different CR theories and many of the conflicting results in the literature may be a symptom of researchers failing to separate judgment tasks according to the unique cognitive processes specific to each judgment task (Ash, 2009; Ash & Wiley, 2008). The current study investigated whether the different judgment tasks predominantly used in contemporary hindsight bias research trigger different cognitive mechanisms within the judgment formation process. Specifically, the study examined whether judgments of the likelihood of possible outcomes to situations and metacognitive assessments of confidence in the predictions rely on different cues and mental representations which lead to the activation of different judgment formation processes. Due to these task and processing differences, the theories required to explain the pattern of hindsight bias must be unique to each judgment task.

The goal of the current investigation is to provide support of a new approach in modeling hindsight effects that is designed to eliminate confounded hindsight findings due to the lack of judgment task differentiation. In the following sections, I first introduce CR theories of the hindsight bias and discuss unitary and non-unitary hindsight bias models. Then I discuss the differences between the two types of judgment tasks that are commonly used in hindsight bias research and the implications of modeling hindsight

findings for these different tasks in accordance with unitary and non-unitary models. This is followed by a discussion of how outcome congruency manipulations can be used to test different unitary and non-unitary theories of the hindsight bias. Finally, I report findings of an experiment that tested differential unitary and non-unitary model predictions of hindsight bias patterns. Using a scenario based, within-subjects hindsight bias paradigm, the experiment tested whether the effects of outcome congruency on hindsight bias patterns were moderated by judgment task. Support is found for non-unitary models with findings providing evidence for modeling hindsight effects separately for each judgment task.

Unitary Cognitive Reconstruction Theories

Cognitive reconstruction (CR) theories of the hindsight bias generally propose that exposure to outcome information biases retrospective judgment making toward the given outcome. Therefore, when trying to recreate their initial predictive judgment, individuals tend to overestimate their predictive accuracy thus creating the hindsight bias. Several CR models have been developed that propose differing cognitive processes to explain exactly how people reconstruct their prior judgments. In categorizing similarities between these models, Hawkins and Hastie (1990) differentiated between two general classes of CR theories that utilize different reconstructive processes to explain hindsight effects: the Anchoring and Adjustment theories and the Updating and Rejudging theories.

Anchoring and Adjustment theories propose that people attempt to reconstruct their predictive judgment by using outcome information as an anchor and then adjust their retrospective estimate from the given outcome by using some metacognitive or experiential cue. (Fischhoff & Beyth, 1975; Hoch & Loewenstein, 1989; Ofir &

Mazursky, 1990; Sanna & Schwarz, 2007; Schkade & Kilbourne, 1991; Schwarz & Stahlberg, 2003; Tversky & Kahneman, 1974; Werth & Strack, 2003; Werth, Strack, & Förster, 2002). Hindsight effects occur because people, when trying to make plausible estimates, are generally overly optimistic in their predictive abilities and therefore make insufficient adjustments during retrospection. Thus, hindsight effects result from people's inability to appropriately utilize subjective cues in reconstructing predictive judgments.

Updating and Rejudging theories propose that exposure to outcome information affects people's representation and mental model of the situation, which leads to a new and updated representation. Individuals then make their retrospective judgments by rejudging the situation using their current mental representation. However, since this representation has been affected by outcome information, people's retrospective judgments tend to be biased in favor of the given outcome (Ash, 2009; Blank & Nestler, 2007; Nestler, Blank, & von Collani, 2008a, 2008b; Carli, 1999; Fischhoff, 1975; Hasher, Attig, & Alba, 1981; Hawkins & Hastie, 1990; Hoffrage, Hertwig, & Gigerenzer, 2000; Pohl, Eisenhauer, & Hardt, 2003; Pezzo, 2003; Pezzo & Pezzo, 2007; Roese & Olson, 1996; Schkade & Kilbourne, 1991).

Ash (2009) then further specified two unique types of reconstruction processes that have been proposed within each general CR class. Within the Anchoring and Adjustment theories two different adjustment mechanisms were proposed; the expectation-based adjustment mechanism and the experience-based adjustment mechanism. Likewise, two different updating mechanisms were proposed within the Updating and Rejudging theories: the automatic assimilation mechanism and the sense-making mechanism.

Theories proposing an *expectation-based* adjustment mechanism propose that people attempt to use “surprise” as a cue in evaluating how different the outcome information is from whatever they previously knew about the event and the judgment (Hoch & Loewenstein, 1989; Ofir & Mazursky, 1990; Sanna & Schwarz, 2007). By using the cue of how “surprising” they found the given outcome, people adjust their retrospective judgment using this subjective information. For example, if a person recalls that the outcome was expected then it will lead to an “I would have known that” feeling. This feeling will cause the person to make only a small adjustment from the 100% likelihood anchor, which often leads to an overestimation of predictive accuracy (hindsight bias). However, if a person feels that the outcome was surprising then it will lead to an “I would have never known that” feeling. This subjective feeling will cause a larger adjustment and lead to retrospective judgments that do not as greatly overestimate predictive accuracy, thereby lessening the hindsight bias effect. Furthermore, in situations that are highly surprising the adjustment may even lead to an underestimation of predictive accuracy and cause a “reverse” hindsight bias effect.

Theories advancing an *experience-based* adjustment mechanism propose that people generally do not remember or recall their original judgment and, at retrospection, use outcome information as an anchor in reconstructing their original judgment. Adjustment from this anchor when producing a retrospective judgment is based upon experiential beliefs. The magnitude and direction of the hindsight effect then depends on people’s subjective assumption about their confidence in their predictive ability or beliefs about their expertise in the judgment domain (Schwarz & Stahlberg, 2003; Werth & Strack, 2003; Werth, Strack, & Förster, 2002). These theories propose that people are

generally overly optimistic about their knowledge in a judgment domain or overly confident in their predictive accuracy and therefore endorse that their prior estimate was closer to the given outcome than their original estimation actually indicated (producing a hindsight bias). However, if people felt that the outcome was unpredictable or lacked knowledge about the judgment domain, then a larger adjustment would be made thus reducing, reversing, or eliminating the hindsight bias.

Automatic assimilation theories propose that people use the same type of judgment process to make both the predictive and the retrospective judgments (Carli, 1999; Fischhoff, 1975; Hasher, Attig, & Alba, 1981; Hawkins & Hastie, 1990; Hoffrage et al., 2000; Pohl et al., 2003). Generally, it is proposed that people make predictive judgments based on the amount of outcome supporting information accessible in their mental representation of the situation. Outcomes that have more accessible supporting information are judged as more likely, while outcomes that have less accessible supporting information are judged as less likely. During retrospection, people simply rejudge the situation using the same process used to formulate their predictive judgment. However, at retrospection, outcome information has been assimilated or integrated into their representation of the situation. This assimilation process renders the outcome-supporting information more accessible in memory. Therefore, when making retrospective judgments, people are rejudging the likelihood of the potential outcomes using an updated mental representation that favors the given outcome.

Sense-making theories propose a “sense-making” or a “causal reasoning” process responsible for producing hindsight effects (Ash, 2009; Blank & Nestler, 2007; Nestler, Blank, & von Collani, 2008a, 2008b; Pezzo, 2003; Pezzo & Beckstead, 2008; Pezzo &

Pezzo, 2007; Roese & Olson, 1996; Schkade & Kilbourne, 1991). Sense-making has been conceptualized as a set of motivated problem-solving cognitions that occur during the comprehension, interpretation, solution, and explanation of an event (Anderson, Krull, & Weiner, 1996). The process of “sense-making” then is the search for potential explanations, or causes, that suitably support the occurrence of a particular outcome. In general, these theories postulate that people will only update their knowledge or beliefs when their current representation of the situation is incongruent with the given outcome. These theories propose that incongruent outcome information activates “sense-making” mechanisms. Successful sense-making will lead to an updated representation of the situation that is more in line with the outcome information. This updating of the problem representation occurs only in situations where the given outcome information does not fit coherently, and thus does not make sense, with the pre-outcome information. Greater hindsight bias effects are then produced following incongruent outcomes in contrast to more congruent outcomes. Two research camps have produced comprehensive sense-making models, Blank and Nestler (2007; Nestler, Blank, & von Collani, 2008a; 2008b) and Ash (2009).

Non-Unitary Cognitive Reconstruction Theories

In addition to the unitary hindsight CR theories, there is a growing consensus in the literature that “the hindsight bias” is not a singular phenomenon (see Blank, Nestler, von Collani, & Fischer, 2008; Hertwig, Gigerenzer, & Hoffrage, 1997; Kelman, Fallas, & Folger, 1998). In an effort to move the conceptualization of “hindsight bias” away from a singular and unitary view, these CR theories decompose the “hindsight experience” into separate and unique sub-phenomena. These multifaceted, non-unitary theories attempt to

account for the different “hindsight experiences” by breaking down the hindsight bias into separate experiences, processes, or components. Recent advancements in this non-unitary view of hindsight bias have been made by Pezzo and Pezzo’s (2007) *Motivated Sense-Making Model*, Müller & Stahlberg’s (2007) *Dual-Process Model*, and Blank, Nestler, von Collani, and Fischer’s (2008) *Separate Components View* (2008).

According to Pezzo and Pezzo’s (2007) *Motivated Sense-Making Model*, hindsight bias is the result of two distinct processes: sense-making and defensive processing. Unexpectedly negative and self-relevant outcomes typically trigger a search (the sense-making process) for external, but not internal causes for the outcome. This *sense-making process* is activated when outcome information is inconsistent with prior knowledge. Successful sense-making (finding an acceptable external cause for the outcome) leaves people with an updated representation of the situation that favors the given outcome. On retrospective judgments, people use this updated representation to reconstruct their predictive judgment, which leads to the hindsight bias. A failure to uncover external causes often results in defensive processing.

Defensive processing is activated when judgments are made in a self-relevant domain (i.e. situations where outcomes have positive or negative impacts on the person making the judgment). In these domains, negative outcomes will cause people to discount or ignore the outcome in order to protect their self-esteem. In doing so, a more accurate assessment of their predictive judgment is facilitated, attenuating hindsight bias effects. However, in some instances, internal causes may be so undeniable that responsibility is accepted for the negative outcome and the hindsight bias results.

Blank, Nestler, von Collani, and Fischer's *Separate Components View* (2008) argues that within the hindsight bias literature there are three different hindsight bias experiences that emerge: memory distortion experiences, impressions of foreseeability, and impressions of necessity. Memory distorting experiences refer to hindsight effects in which, after having received feedback about the outcome of an event or the answer to a factual knowledge question, people's recollections of their own prior judgments are biased in favor of the direction of the feedback. The impression of foreseeability describes the tendency for people to believe they would have been able to predict, or that they knew all along, how an event would conclude. Impressions of necessity refer to hindsight effects where, once the outcome is known, the probability of event outcomes are perceived as more necessary and inevitable (more probable) in hindsight than in foresight.

Furthermore, the authors claim that these three different hindsight components (experiences) are distinguished from each other by differing qualities of four features; the entities the components refer to (*entity*), the content or object (*content*), the psychological process (*process*), and the functions they serve the individual (*function*). Notably, the authors hold that each component is driven by a distinct psychological process. They suggest that causal attribution is the main process underlying necessity impressions, foreseeability is driven by metacognitive considerations, and memory distortions are elicited through the memory processes of anchoring on the outcome and reconstructing one's initial prediction from the anchor.

The *Dual-Processes Model* of hindsight bias proposed by Müller and Stahlberg (2007) was aimed at addressing some of the contradicting predictions and results

regarding the role of surprise in hindsight bias effects. This model attributes hindsight differences as a combination of the activation of sense-making processes and expectation-based anchoring and adjustment processes. The dual process model suggests that the subjective feeling of surprise influences hindsight effects through two different routes. First, it is proposed that surprise can be used as a heuristic cue in the reconstruction of pre-outcome predictions. In this sense, the feeling of surprise alerts one to an inaccurate or unpredicted outcome. Secondly, it is proposed that surprise can also act as a trigger to elicit a biased sense-making process when a certain “surprise” threshold is reached.

Hindsight effects are then determined by the activation and utilization of these two processes, which are influenced by both motivational levels and/or cognitive load capacity. This model posits that in high motivation or low cognitive load situations, surprising outcomes should be likely to activate resource demanding sense-making processes. However, in low motivation or high cognitive load situations, simpler and more automatic surprise-based heuristic adjustment mechanisms would be activated. Due to these differing reconstruction mechanisms, opposite hindsight bias patterns are expected to be observed under differing motivational situations or cognitive load constraints. Specifically, the sense-making processes would lead to hindsight bias only for surprising or unexpected outcomes, because these are the types of situations which would activate sense-making. The expectation based anchor and adjust mechanisms would only lead to hindsight bias on unsurprising or expected outcomes. In these situations people exhibit the metacognitive “I would have known that!” feeling that leads to under adjustment from the overconfidence in their predictive judgment ability.

While these non-unitary models have made contributions to the notion that the “hindsight bias” phenomena may be caused or determined by multiple cognitive processes, they have not proposed that differences in judgment tasks may result in different patterns of hindsight findings. Again, I propose that some of the opposing predictions and conflicting findings in the literature may be a symptom of researchers failing to separate judgment choices according to the cognitive processes that are specific to each judgment task. Next, I discuss the differences between the two types of judgment tasks that are commonly used in hindsight bias research and the implications of modeling hindsight findings for these different tasks in accordance with unitary and non-unitary models.

Judgment Tasks

Two main types of judgment tasks used to investigate the hindsight bias are situational judgment tasks and metacognitive assessments (Ash & Wiley, 2008; Christensen-Szalanski & Willham, 1991; Guilbault, Bryant, Brockway & Posavac, 2004; Hawkins & Hastie, 1990; Hoffrage & Pohl, 2003; Pohl, 2007). Both of these judgment tasks are designed to provide laboratory models of frequently occurring real-life judgments where the occurrence of the hindsight bias may have severe detrimental effects (Fischhoff, 2007; Louie, Rajon, & Sibley, 2007). As examples of these detrimental effects, inaccurate retrospective judgment processes have been shown to occur in stock purchases (Louie, 1999), political decisions (Blank, Nestler, von Collani & Fischer, 2008), juror’s decisions (Casper, Benedict, & Perry, 1989), victim degradation (Carli, 1999), as well as healthcare and medical decisions (Arkes, Faust, Guilmette, & Hart, 1988; Borum, Otto, & Golding, 1993). By understanding how retrospective judgments

are constructed, better interventions can be developed to help prevent the harmful effects of the hindsight bias.

Situational judgment tasks commonly assess outcome likelihood predictions. Outcome likelihood predictions involve asking participants to predict the likelihood of the outcome of an event or situation. As an example, participants would first be presented a narrative story or a description of some situation. They then would be asked to predict the probability of different outcomes to the event or situation. For example, Ash (2009) presented this question prompt to participants after they read a narrative of a tennis match between two players: “Either Mark Krause won the match OR Nathan Mitchell won the match. Use the scale below to indicate your opinion of how likely the two outcomes are based on the story.” After this predictive judgment phase, feedback consisting of either the conclusion to the story or a description of the “true” outcome of the event would be given to the participants (i.e. Mark Krause won). Hindsight bias on outcome likelihood judgments is then evidenced by higher retrospective likelihood ratings for the given outcome.

Metacognition refers to “cognition about cognitive phenomena” (Flavell, 1979). In hindsight bias paradigms, metacognitive assessments would include any task that asks people to assess the nature of their own memory, knowledge, skill, abilities, or expertise (Ash & Wiley, 2008). A primary type of metacognitive judgment that has been used in hindsight bias research is a confidence rating. Confidence judgments usually use trivia problems to ask participants to assess the likelihood they are correct after selecting a response or choosing an answer (e.g. Hoffrage, Hertwig, & Gigerenzer, 2000; Which food do you think has more cholesterol, chocolate fudge cake or pie? How confident are

you that your choice is correct?). The feedback in these tasks consists of either being given the correct answer to the question or being given feedback about the accuracy of one's own response.

Confounding of Judgment Task on the Hindsight Bias.

It can be argued that situational (likelihood) judgments and metacognitive (confidence) assessments involve fundamentally different cognitive processes during the problem representation and judgment formation processes (Ash, 2009; Ash & Wiley, 2008; Hawkins & Hastie, 1990). It seems then that a major part of the theoretical confusion as to whether the hindsight effect is a unitary or non-unitary phenomenon stems from researcher not differentiating between judgment tasks. Results that may seem inconsistent or conflicting in the literature may be due to the fact that researchers are assuming a unitary explanation for the hindsight bias across judgment tasks. However, if we assume that these different types of judgment tasks involved different reconstruction processes, then we would expect different variables and manipulations to have different effects on hindsight bias.

Differences between situational judgments and metacognitive assessments have already appeared in the problem solving and comprehension literatures. In regards to situational judgments, much work has already been done in the area of how people construct, integrate, store, and update narrative information and it has been proposed that the formation of a mental problem representation relies on the same cognitive processes as the comprehension of events, situations, or texts (Kintsch, 1988, 1998; Trabasso & Wiley, 2005). As narrative texts serve as the problem stimuli for situational judgments, construction integration models of text representations therefore seem to be more than

adequate in explaining how mental representations of situational judgments are formed. Generally, narrative comprehension theories contend that new information is entered into a representation and connected with preexisting information already in memory. The integration of new information into memory updates the “accessibility” of information, thus changing the connection strength between information units. New information is proposed to be connected or integrated into an ongoing representation by either “resonance” mechanisms (Kintsch, 1998; Myers & O’Brien, 1998) or through the changes based on causal relationships (Langston & Trabasso, 1999; Langston, Trabasso, & Magliano, 1998; Trabasso & Bartolone, 2003; Trabasso & Wiley, 2005; Trabasso & van den Broek, 1985). Regardless of the mechanism, prior information that is connected to the new information increases the relative accessibility of those connected information units to a greater degree than information unit pairs that are not connected.

Unfortunately, less is known about how metacognitive assessment cues are represented in memory. Van Overschede (2008) contends that most investigations into metacognitive assessments focus on one’s interpretation or assessment of the *accessibility* of the metacognitive cues while neglecting the actually representational structure of the cue influencing these assessments. He notes that the structure of the knowledge base of the cue, which provides the foundation for true metacognitive decision, has “been underemphasized in metacognitive research and theory” and that future research is needed to compensate for this error (Van Overschelde, 2008, p. 65). However, both the expectation and experience based adjustment mechanisms within the anchoring and adjustment hindsight theories have been shown to successfully account for hindsight bias effects in these types of judgments (Hoch & Loewenstein, 1989; Ofir & Mazursky, 1990;

1997; Sanna & Schwarz, 2007; Schwarz & Stahlberg, 2003; Werth & Strack, 2003; Werth, Strack, & Förster, 2002).

Judgment Task Differentiation

Ash and Wiley (2008) and Ash (2009) have proposed a non-unitary approach to modeling the hindsight bias that differentiated between judgment tasks based on how mental representations influence the judgment formation and reconstruction processes. In Ash and Wiley (2008), they proposed that the judgment reconstruction processes described by Anchor and Adjustment theories might provide a plausible explanation for hindsight bias effects on metacognitive assessments because these judgments use the types of metacognitive cues (i.e. domain self-efficacy or feeling of knowing) described in the expectation and experience based adjustment models. They also proposed that the judgment reconstruction processes described by Updating & Rejudging theories might provide a plausible explanation for the hindsight bias for situational judgments used in narrative text paradigms. They proposed that these judgment tasks require people to form a mental representation of the novel situation described in the narrative text and that the judgments depend on the information available in one's mental representation. In line with their predictions, using multi-component mathematical and insight problems in a within-subjects hindsight bias paradigm, they found different patterns of hindsight bias on metacognitive judgments (people's confidence in their ability of solving a problem) and situational judgments (people's assessment of the importance of the different components of a problem) depending on the type of problem, availability of feedback, and solution success.

Furthermore, Ash (2009) found that sense making theories within the Updating and Rejudging CR class best described hindsight results on situational judgments. Using a narrative text paradigm, Ash investigated the influence of surprise (manipulated by the congruency between pre-outcome information and outcome information) on the hindsight bias of event-likelihood ratings (situational judgments). Results indicated that the hindsight bias did not occur in situations where the given outcome was congruent with the majority of outcome supporting information presented in the narrative. The hindsight bias only occurred in situations where the initial representation was ambivalent to or incongruent with the given outcome, supporting the idea that active sense-making processes are involved in the process of updating the problem representation during retrospective judgment making for situational judgment domains. Additionally, Nester and Egloff (2009) also provided support that sense-making or causal reasoning processes account for hindsight bias effects on event likelihood judgments. Nestler and Egloff (2009) found that providing explainable outcomes to surprise trivia questions moderated hindsight bias effects for outcome likelihood ratings (impressions of necessity/inevitable) but not for metacognitive assessments (impressions of foreseeability). These empirical findings therefore provide preliminary evidence that indicates that the hindsight bias in metacognitive assessments can best be explained by an expectation based anchoring and adjusting heuristic and the hindsight bias in situational judgment tasks can best be explained by causal reasoning or sense-making processes (Ash & Wiley, 2008; Ash, 2009; Nester et al., 2008a, 2008b; Nestler & Egloff, 2009).

Experiment: Likelihood and Confidence Judgments

What is lacking in the hindsight bias literature is a direct empirical test demonstrating the independence of outcome likelihood and confidence judgment tasks. Therefore, the current experiment tested a non-unitary approach to modeling the hindsight bias based on Ash and Wiley (2008) against a unitary approach. To accomplish this, I used the text based scenario developed by Ash (2009). This scenario was designed for testing differing predictions of outcome congruency on hindsight effects within a case-study or narrative text paradigm. The scenario and research design allows one to test competing models of hindsight bias in a single domain where the information available to a participant at the points of prediction and retrospection can be controlled.

As noted by Ash (2009), one way in which CR theories differ is in the proposed effect of expectation or the surprising nature of an outcome on the hindsight bias. To manipulate surprise, participants were asked to read a story describing an upcoming tennis match between two players. The story described the strengths and weaknesses of each player. An equated version of the text was created that presented equal amounts of evidence to support each players' victory. From this equated text, an outcome-supporting version for each player was developed by removing pieces of evidence that supported the other tennis player's victory. When these introductory texts are combined with the two possible outcomes, it leads to three types of outcome conditions: Congruent (where the outcome matched that supported by the story), Ambivalent (either outcome matched with the equated story), and Incongruent (where the outcome was the opposite of that supported by the story). In this paradigm, when preoutcome information (the introductory text) is congruent with the outcome (who won the match), it is an expected or

unsurprising outcome. However, when preoutcome information is incongruent with the outcome, this is called an unexpected or surprising outcome.

For the procedure, participants first read the introductory story. Then, they were asked to rate the likelihood of the two possible outcomes on a continuum anchored on each player's victory. Then they read a passage describing who won and then rated how surprising they found the outcome. Finally, participants returned to the lab a week later and attempted to recall their original predictions. The hindsight bias in this paradigm would be observed if retrospective judgments would be systematically biased toward the given outcome.

Using this paradigm, based on the non-unitary approach of Ash and Wiley (2008) and Ash (2009), a judgment type (metacognitive confidence assessment vs. situational likelihood rating) by outcome congruency (incongruent, congruent) interaction on hindsight results is predicted. Sense making theories are predicted to provide the most plausible explanation of hindsight findings for situational judgments and the expectation-based adjustment model to provide the most plausible explanation for hindsight findings on metacognitive judgments. Therefore, for situational judgment tasks, sense-making theories predict the most hindsight bias after surprising outcomes, because surprising situations will activate the sense-making processes leading to a biased, updated representation that will be used during retrospective judgment making. For metacognitive judgments, expectation based adjustment models predict that the most hindsight bias should occur on expected outcomes because these outcomes will be the most likely to elicit the "I would have known that!" feeling that leads to overly-adjusted retrospective judgments.

However, a unitary approach to modeling hindsight findings predicts no judgment type by outcome congruency interaction on hindsight results. In this unitary approach, sense making theories predict the occurrence of the hindsight bias only in the incongruent outcome condition regardless of the judgment task. In a similar fashion, expectation based adjustment models predict the occurrence of the hindsight bias only in the congruent outcome condition for both situational judgments and metacognitive assessments.

In sum, if likelihood and confidence judgments are indeed separate tasks governed by differing cognitive processes, the sense making theories would best predict hindsight bias findings resulting from situational likelihood judgment tasks and expectation-based adjustment models would best predict hindsight bias findings from metacognitive confidence assessments. Patterns of the hindsight bias would therefore differ according to which judgment task is completed. Metacognitive assessments would show hindsight effects only in an outcome congruent condition while situational judgments would show hindsight effects only in an outcome incongruent condition. However, if these judgment tasks are not independent, then no differences in the pattern of hindsight bias findings between judgment tasks will be observed, thus supporting predictions based on a unitary explanation for modeling hindsight effects. Table 1 illustrates the judgment type by outcome congruency hindsight predictions for the unitary model and non-unitary models.

Table 1

Predictions

		HB predictions	HB predictions
Judgment Tasks	Non-Unitary Theory	Incongruent	Congruent
Metacognitive	Expectation-based	No HSB	HSB
Situational	Sense making	HSB	No HSB
Judgment Tasks	Unitary Theory	Incongruent	Congruent
Metacognitive	Expectation based	No HSB,	HB
Metacognitive	Sense making	HB	No HSB
Situational	Expectation based	No HSB,	HB
Situational	Sense making	HB	No HSB

Note. The Unitary versus Non-Unitary predictions of hindsight effects by judgment type and outcome congruency.

CHAPTER II

METHOD

Participants

Based on the average hindsight bias effect sizes reported in meta-analyses (Christensen-Szalanski & Willham, 1991; Guilbault, Bryant, Brockway & Posavac, 2004) and the Ash (2009) experiments, between 40 (Cohen's $d = .4$) and 68 (Cohen's $d = .3$) participants were needed in each congruency experimental conditions (Congruent and Incongruent outcome conditions) in order to test for the moderation effects of judgment type by outcome congruency on hindsight effects proposed by the different hindsight bias theories. Two hundred fifty four introductory psychology students from Old Dominion University participated in both sessions of this study for course credit (72.4% women; M age = 21.44 years, $SD = 6.46$ years; Range = 18–54 years; 95.7% native English speakers). Table 2 illustrates the proposed and obtained sample size per condition.

Table 2

Condition N Sizes

Tennis Match	Preoutcome information	Outcome information	<i>Proposed N</i>	<i>Obtained N</i>
Congruent	Krause supporting	Krause wins	30	32
	Mitchell supporting	Mitchell wins	30	31
Incongruent	Krause supporting	Mitchell wins	30	30
	Mitchell supporting	Krause wins	30	30
Job Promotion				
Congruent	Keller supporting	Kellar wins	30	32
	Davidson supporting	Davidson wins	30	33
Incongruent	Keller supporting	Davidson wins	30	33
	Davidson supporting	Kellar wins	30	33

Note. Design of Preoutcome and Outcome Information Congruency Manipulation with Sample Sizes by Text Scenario.

Materials

Two narrative stories were used in this experiment, one utilized in Ash (2009) which describes a tennis match and one I have developed and piloted that describes a job promotion. Ash (2009) used a pre-outcome narrative text that described an upcoming championship tennis match between two fictional players, Mark Krause and Nathan Mitchell. The story was designed to equate the amount of causal information in the text that supported either player's victory. Appendix A contains the tennis match text and illustrates which sentences, if deleted, provide support for an outcome that favors either Krause or Mitchell. Two outcome information texts were created for the story. These texts were designed to inform the participant as to the outcome of the text, with either a "Krause Wins" outcome or a "Mitchell Wins" outcome.

The narrative story I created utilizes a narrative text with the domain of a job promotion as the subject matter of the story and predictions of who will get the promotion as the judgment domain. This manipulation will serve to help show whether the idea that patterns of the hindsight bias differ according to judgment tasks is a robust explanation of the hindsight bias effect across differing domains. As in the tennis match story, the job promotion story was designed to equate the amount of causal information in the text that supported either businessman's successful promotion, either Jeffrey Keller or Michael Davidson. Also, two outcome information texts were created for this story, informing the participant as to either a "Keller got the promotion" outcome or a "Davidson got the promotion" outcome. Appendix B contains the job promotion narrative text.

Design and Procedure

Participants were randomly assigned to either the tennis match or job promotion story. For either story, participants were randomized to one of eight story orders to control for order effects. An E-Prime application running on laboratory computers presented all directions, experimental materials, and questions as well as collected all participant responses.

The narrative protocol used in Ash (2009) was closely replicated for both stories; differing in that participants were randomly assigned to either a pre-outcome metacognitive assessment task condition or a pre-outcome event likelihood (situational) judgment task condition. The experiment consisted of two sessions that took place exactly 1 week apart. The first session involved two main phases: a practice phase and an experimental phase. Participants were told that they are participating in a study on reading comprehension in which they will be asked to read stories and answer opinion questions about the stories. The practice phase involved a reading task, rating tutorial, and rating tasks. Participants first read a practice story and then they read a short tutorial which described the rating procedure. They then answered questions about the likelihood of two possible outcomes using the same procedure as in the experimental phase. The experimental phase occurred directly after the practice phase and involved the pre-outcome information reading task, pre-outcome metacognitive confidence rating or event likelihood rating, outcome information reading task, and post-outcome surprise rating.

For the experimental phase, participants were randomly assigned to a pre-outcome scenario (i.e. a Krause supporting or Mitchell supporting text). Participants were also randomly assigned to which outcome text they received (Krause Wins or Mitchell Wins). The combination of the pre-outcome and outcome texts resulted in two

information-outcome congruency conditions (Congruent and Incongruent). The pre-outcome text and the outcome text were presented via a self-paced reading paradigm. Each sentence of the text was presented on the screen one at a time with participants advancing through the text by pressing the space bar. Directly after reading the pre-outcome text, participants were asked to either make a metacognitive assessment or an event likelihood rating of the two possible outcomes. Specifically, for the metacognitive assessment, participants were asked “How confident are you in predicting who will win the job promotion/tennis match? Use the scale below to indicate your opinion of how confident you are in your ability to predict who will win.” Below the metacognitive question, a confidence rating was flanked by anchors of “not at all confident” and “very confident”. For the event likelihood rating, participants were asked “Either Mark Krause/Jeffrey Kellar won the match OR Michael Davidson/Nathan Mitchell won the promotion/match. Use the scale below to indicate your opinion of how likely the two outcomes are based on the story.” Below the event likelihood question, a continuum that is flanked on either side by “Kellar/Krause Wins” and “Davidson/Mitchell Wins” was presented. For both the confidence and event likelihood rating, the continuum was initially blank. However, after reading the question, when participants press the space bar a marker appears at a random location somewhere in the middle third of the scale. Participant then indicate their response by moving the marker on the scale between the two possible outcomes. The continuum allows for 79 possible marker locations. Participants are able to move the marker along the scale by pressing the *l* key to move left or the *j* key to move right. Each press moves the marker one space on the scale. Participants press the Enter key to indicate their final response. The program accepts a

response only if the marker moves at least once. This measure serves as the predictive judgments used to test whether the information congruency manipulation affects participants' outcome expectation and as the within-subjects comparison for hindsight bias observations.

To assess post-outcome surprise, immediately after reading the outcome information, participants were asked, "How surprising was it that [outcome]?" Depending on the outcome condition, "[outcome]" is replaced by either "Jeffrey Kellar/Mark Krause won the promotion/match" or "Michael Davidson/Nathan Mitchell won the promotion/match." Participants then rated their surprise by using the same procedure as the other ratings, differing in that for this measure the continuum is anchored by "Not at all surprising" and "Very surprising". This measure serves as the surprise rating that is used to test whether the information-outcome congruency manipulation affected participants' subjective reaction to the outcome. This surprise rating concluded the session 1 experimental phase. After completing this rating all participants were asked not to discuss the text they read or the questions they were asked with anyone in the subject pool (including other participants in their group) and were dismissed.

In the second session one week later, participants completed a post-outcome memory-rating task, which asked them to attempt to recall their pre-outcome confidence rating or likelihood rating. They were presented with the following directions: "Your task is to attempt to remember your answer to each of the questions from last week's session. To do this you will move the marker into the SAME position on the rating line as you put it during last week's session. Remember your goal is to try to reproduce your original ratings from last week's session. You will do this by moving a marker on a scale in the

same manner as last week. Pressing the 1 KEY will move the marker to the LEFT.

Pressing the 3 KEY will move the marker to the RIGHT. When the marker is at the same position as it was on the question asked last week, press ENTER to record your response.

Please try your best at remembering your rating from last week on each of the questions.”

The participants, according to which judgment type condition they were randomly assigned to in session 1, were then presented either the pre-outcome confidence rating question or pre-outcome likelihood rating question. The post-outcome memory rating served as the measure of the participants' retrospective judgments. Then, upon completion of the memory ratings, participants were debriefed as to the purpose of the study and reminded not to speak with anyone about the materials or questions appearing in the study.

CHAPTER III

RESULTS

Preoutcome Predictive Judgment Ratings

In order to test the effects of expectation on hindsight bias effects, the manipulation of preoutcome information must affect participants' predictive judgments of the given outcome. People should judge the given outcome, which is the outcome they are about to receive, as most expected in the Congruent condition and least expected in the Incongruent condition. For analysis, preoutcome predictive ratings were centered on the middle value of the rating continuum (range = -39 to 39) and recoded in order for positive scores to represent judgments in favor of the given outcome and negative scores to represent judgments in favor of the alternative outcome. Then to investigate the effects of the story bias manipulation on predictive judgments, I performed a 2 (judgment task: metacognitive vs. situational) X 2 (outcome congruency: incongruent vs. congruent) X 2 (text: tennis match vs. job promotion) factorial ANOVA on mean predictive judgments. Result indicate a significant difference between the congruent and incongruent groups, $F(1, 246) = 76.87, p < .001$, partial $\eta^2 = .238$. Additionally, I performed planned one-sample t tests against a population mean of zero which revealed that participants in the Congruent condition favored the given outcome ($M = 8.23, SD = 15.50$), $t(127) = 6.01, p < .001$, Cohen's $d = 0.531$; those in the Incongruent condition favored the alternative outcome ($M = -9.52, SD = 17.30$), $t(125) = -6.17, p < .001$, Cohen's $d = 0.550$. These analyses show that the information manipulation designed to bias the story toward the different outcomes had a significant effect on participants' predictive judgments.

A note should also be made that analyses also indicated a significant judgment type X outcome congruency interaction, $F(1, 246) = 13.67, p < .001$, partial $\eta^2 = .053$. However, simple effect comparisons of the judgment type X outcome congruency interaction for predictive ratings indicated non cross-over interactions. For metacognitive assessments, the simple effect test of outcome congruency indicated that predictive ratings differ across congruency conditions, $F(1, 246) = 12.95, p < .001$, partial $\eta^2 = .050$. The same effect was found for situational judgments, $F(1, 246) = 77.09, p < .001$, partial $\eta^2 = .239$. In comparison to the congruency conditions for the metacognitive assessments (Incongruent: $M = -5.56, SD = 14.50$; Congruent: $M = 4.85, SD = 13.65$), the situational judgments had greater predictive ratings in both the Congruent condition ($M = 11.71, SD = 16.60$) and the Incongruent condition ($M = -13.48, SD = 18.62$). Non cross-over interactions, or quantitative interactions, occur when there is variation in the magnitude, but not in the direction, of treatment effects among subsets (Gail & Simon, 1985). Therefore, the non cross-over interactions did not confound any manipulation effect. Supporting this are the results which indicate that the outcome congruency manipulation had a significant effect for all intended subsets.

Surprise Ratings

To test the design assumption that the manipulation of preoutcome information also affected how surprising participants found the outcome information, I conducted a 2 (judgment task: metacognitive vs. situational) X 2 (outcome congruency: incongruent vs. congruent) X 2 (text: tennis match vs. job promotion) factorial ANOVA on mean postoutcome surprise ratings (possible range: 1 = *not at all surprising* to 79 = *very surprising*). Results indicated a significant difference in surprise ratings between

congruency groups, with Incongruent outcomes ($M = 46.48$, $SD = 20.25$) being significantly more surprising than Congruent outcomes ($M = 13.03$, $SD = 12.75$), $F(1, 246) = 255.93$, $p < .001$, partial $\eta^2 = .510$.

This main effect was subsumed under a significant text X outcome congruency interaction, $F(1, 246) = 10.48$, $p = .001$, partial $\eta^2 = .041$, as well as a significant judgment task X outcome congruency interaction, $F(1, 246) = 5.00$, $p = .026$, partial $\eta^2 = .020$. However, simple effect comparisons of the interactions indicated significant non cross-over interactions that did not confound any manipulation effect. For the tennis match the simple effect test of outcome congruency indicated that surprise ratings differ across congruency conditions, $F(1, 246) = 191.06$, $p < .001$, partial $\eta^2 = .437$. The same effect was found for the job promotion text, $F(1, 246) = 78.91$, $p < .001$, partial $\eta^2 = .243$. Therefore, in comparison to the congruency conditions in the tennis match, the job promotion text had a smaller surprise rating for the Congruent condition and a larger surprise rating in the Incongruent condition. For metacognitive assessments, the simple effect test of outcome congruency indicated that surprise ratings differ across congruency conditions, $F(1, 246) = 167.55$, $p < .001$, partial $\eta^2 = .405$. The same effect was found for situational judgments, $F(1, 246) = 93.95$, $p < .001$, partial $\eta^2 = .276$. Therefore, in comparison to the congruency conditions for the metacognitive assessments, the situational judgments had a larger surprise rating for the Congruent condition and a smaller surprise rating in the Incongruent condition. In summary, these analyses demonstrate that the outcome congruency manipulation had a significant effect on participants' subjective (surprise) reactions to the outcome information. See Figure 1 for mean surprise ratings by text, judgment task, and outcome congruency condition.

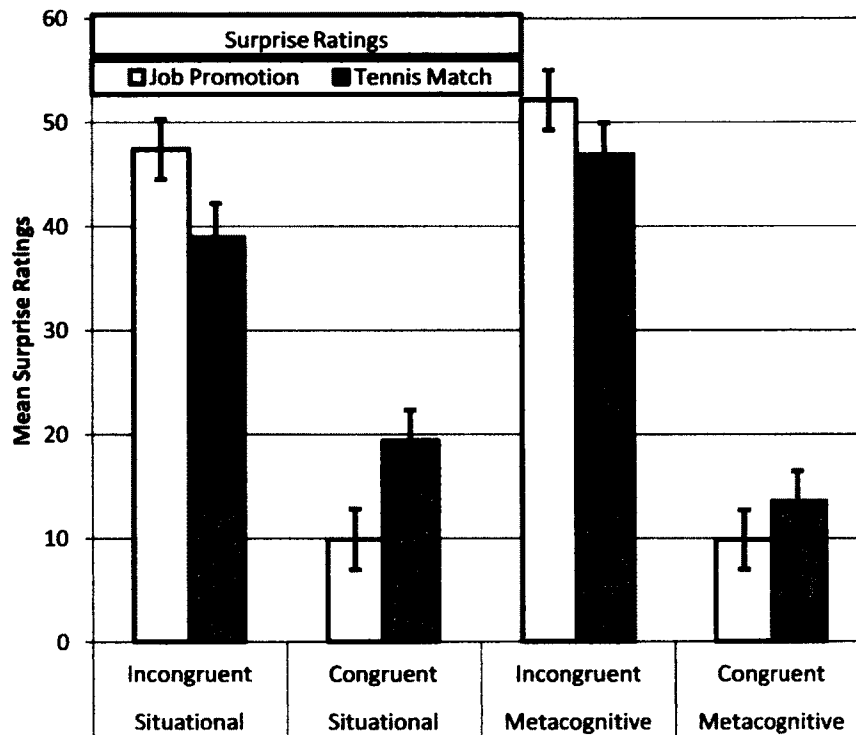


Figure 1. Mean surprise ratings as a function of text, judgment task, and outcome congruency condition. Error bars represent standard error of each mean.

Hindsight Bias

In order to investigate the effects of judgment task and outcome congruency on hindsight effects, a 2 (judgment: predictive vs. retrospective judgment) X 2 (judgment task: metacognitive vs. situational) X 2 (outcome congruency: incongruent vs. congruent) X 2 (text: tennis match vs. job promotion) split-plot ANOVA was conducted on judgment ratings. Driven by the non cross-over interaction of the predictive ratings that were described earlier, results revealed a significant text X outcome congruency interaction for the averaged judgment ratings, $F(1, 246) = 5.15, p = .024, \text{partial } \eta^2 = .021$. Again,

simple effect tests indicated this interaction to be a non cross-over interaction. Figure 2 displays the hindsight bias patterns for the tennis match and Figure 3 displays the hindsight bias patterns for the job promotion text.

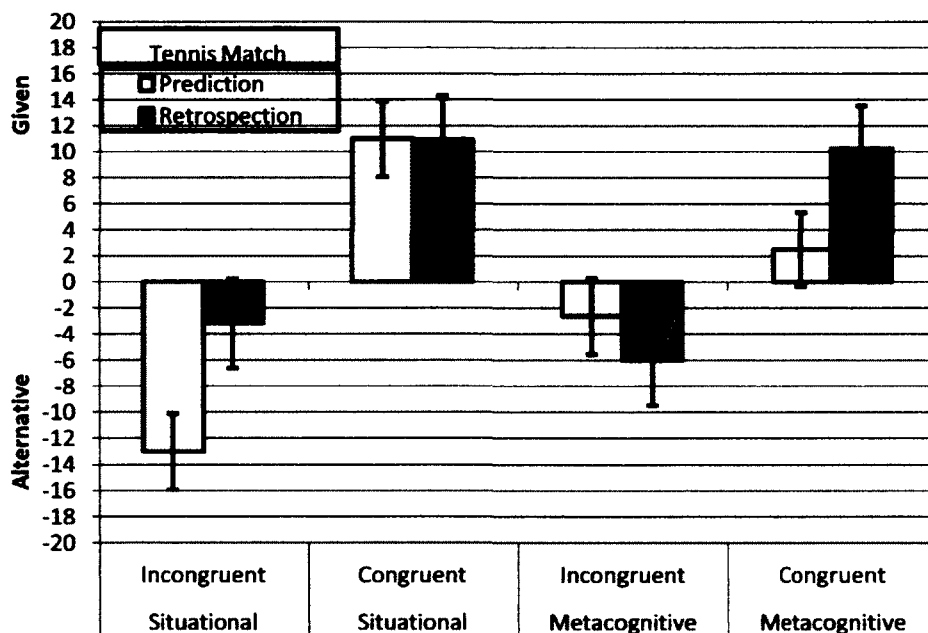


Figure 2. Hindsight bias results: mean predictive and retrospective judgments as a function of judgment task, preoutcome, and outcome congruency condition for tennis match text. Error bars represent standard error of each mean.

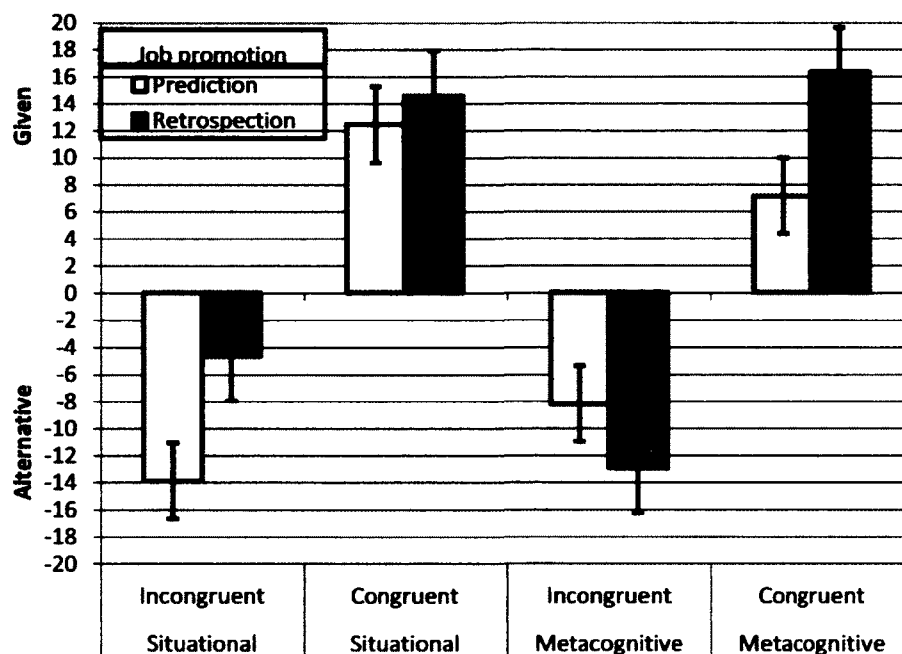


Figure 3. Hindsight bias results: mean predictive and retrospective judgments as a function of judgment task, preoutcome, and outcome congruency condition for job promotion text. Error bars represent standard error of each mean.

More importantly, results revealed a main effect of judgment which demonstrated the traditional hindsight bias effect, $F(1, 246) = 7.23, p = .008$, Cohen's $d = -0.241$. Participants' retrospective judgments were more in favor of the given outcome ($M = 3.19, SD = 21.27$) than their predictive judgments ($M = -0.57, SD = 18.64$). However, where the theories differ in their hindsight bias predictions is in the judgment (predictive vs. retrospective) X judgment task (metacognitive vs. situational) X outcome congruency (incongruent vs. congruent) interaction (See Table 2). The judgment X judgment task X outcome congruency interaction was significant, $F(1, 246) = 14.35, p < .001$, partial $\eta^2 = .055$.

Planned follow up comparisons were conducted to examine judgment X outcome congruency interactions separately for the metacognitive and situational judgments. For

metacognitive judgments, the judgment X outcome congruency interaction was significant, $F(1, 246) = 10.40, p = .001$, partial $\eta^2 = .040$ with further comparisons between congruency conditions providing evidence for the hindsight bias effect in the Congruent condition, $F(1, 246) = 9.55, p = .002$, Cohen's $d = .492$ but not in the Incongruent condition, $F(1, 246) = 2.20, p = .139$, Cohen's $d = .254$. The opposite hindsight bias pattern was revealed within the situational judgment task. For situational judgments, the judgment X outcome congruency interaction was also significant, $F(1, 246) = 4.55, p = .033$, partial $\eta^2 = .018$, with further comparisons between congruency conditions providing evidence for the hindsight bias effect in the Incongruent condition, $F(1, 246) = 11.64, p < .001$, Cohen's $d = .493$ but not in the Congruent condition, $F(1, 246) = 0.15, p = .703$, Cohen's $d = .062$.

CHAPTER IV

DISCUSSION

Using a within-subjects, narrative text paradigm, the current experiment investigated if confidence ratings and outcome likelihood judgments are susceptible to unique patterns of hindsight bias. Based on the non-unitary approach of Ash and Wiley (2008) and Ash (2009), a predicted judgment type by outcome congruency interaction on hindsight bias effects was tested. This interaction prediction specified that unexpected outcome information would produce hindsight bias effects for situational (outcome likelihood) judgments and expected outcome information would produce hindsight bias effects for metacognitive (confidence) judgments. Findings confirmed this predicted interaction with situational and metacognitive judgments producing divergent patterns of hindsight bias; suggesting these tasks to be independent and governed by differing cognitive processes.

The proposed non-unitary approach models situational judgments and metacognitive assessments as utilizing different problem representations and restructuring cues, which activate different judgment formation processes. Due to these task and processing differences, the theories and models required to explain hindsight bias patterns must be unique to each judgment task. The results of this experiment are consistent with the proposed non-unitary hindsight bias approach. For the situational judgment task, sense-making theories accurately predicted the hindsight bias to occur after unexpected outcomes. Sense-making theories attribute the occurrence of the bias to the unexpected outcome (i.e. a surprising situation) activating sense-making processes that led to a biased, updated representation being used during retrospective judgment

making. For the metacognitive assessment task, expectation based adjustment models accurately predicted the hindsight bias to occur after expected outcomes. Expectation based adjustment models attribute the bias to the expected outcome eliciting an “I would have known that!” feeling which led to an overconfident, over-adjusted, retrospective judgment.

This experiment provides a direct empirical test of the independence of hindsight bias patterns between situational (outcome likelihood) and metacognitive (confidence) judgments; replicating, complementing, and extending previous hindsight research that has suggested these tasks to have unique qualities (Ash & Wiley, 2008; Ash, 2009; Blank et al., 2008; Nestler & Egloff, 2009). For example, in addition to finding empirical support for the non-unitary hindsight predictions of Ash and Wiley (2008) and Ash (2009), this experiment expanded the narrative text stimuli used in Ash (2009) to include a job promotion story. This addition shows the generalizability of the patterns of hindsight effects of the judgment tasks across different story content domains. This experiment also replicates and extends the hindsight findings in Nestler and Egloff (2009) while utilizing a different design and materials. In Nestler and Egloff (2009) a between-subjects, trivia question paradigm produced findings that confirmed predictions of 1) sense-making or causal modeling theories to accurately account for hindsight patterns for the surprising outcome likelihood ratings and 2) outcome likelihood ratings and metacognitive assessments to display different hindsight patterns. By replicating these findings, the methodology used in this experiment provided evidence to extend the generalizability of these findings to a within-subjects, narrative scenario paradigm. Furthermore, additional design elements in this experiment allowed for more

comprehensive empirical examinations of the cognitive processes responsible for the differing hindsight patterns. For one, the manipulation of story outcomes allowed for the analysis of both expected (unsurprising) and unexpected (surprising) outcomes. This added manipulation allowed for the predictions of the “I would have known that!” hindsight bias theories to be tested in this experiment. These predictions were unable to be tested in Nester and Egloff (2009) as they only utilized surprising outcomes. Secondly, surprise was experimentally manipulated in this experiment through random assignment to outcome congruency conditions. Nestler and Egloff (2009) did not experimentally manipulate the inducement of surprise, but alternatively relied on the sample’s prior knowledge of the plausibility of trivia questions to elicit surprise. Not experimentally manipulating surprise potentially weakens the accuracy of their proposed generalized causal inference of the relationship between surprising events and hindsight effects (Shadish, Cook, & Campbell, 2002).

In addition to complementing previous hindsight research, this study also provides unique empirical and theoretical contributions. While other non-unitary theories have attempted to account for the different “hindsight experiences”, the non-unitary approach tested in this experiment is unique in that it is the only approach to propose a model of the hindsight bias that differentiates between judgment tasks according to how mental representations influence the judgment formation and reconstruction processes. The results of this experiment provide strong support for the proposition that some of the opposing predictions and conflicting findings in the hindsight bias literature may be a symptom of researchers not separating judgment tasks according to the cognitive processes that are unique to each task.

Based on the findings of the current investigation, modifications to current CR approaches of modeling hindsight bias effects are necessary. While previous CR models have focused their attention on modeling the judgment formation mechanisms, improvements can be achieved if they 1) account for the mental representation of the judgment task and 2) differentiate between the judgment tasks (and the resulting hindsight effects) the theory intends to model. The proposed non-unitary approach investigated here has attempted to integrate these improvements by incorporating the conceptualizations that 1) different judgment tasks rely on different mental representations, 2) mental representations are updated in different ways using different cues, and 3) people formulate retrospective judgments differently according to the representation and updating processes.

Despite providing strong evidence for this alternative non-unitary approach to modeling hindsight bias effects, limitations are present. For one, this is only one experiment. Multiple replications as well as greater theoretical expansions are needed to fully conceptualized and validate this approach. Additionally, researchers have noted that the procedural differences between within-subjects/memory design and between-subjects/hypothetical design paradigms may lead to qualitatively different hindsight effects (Hertwig, Gigerenzer, & Hoffrage, 1997; Pohl, 2007). In a memory design, participants first make predictive judgments and then are asked to recall those judgments after they receive outcome information. Predictive and retrospective judgments are compared within-subjects to investigate evidence of the hindsight bias effect. In a hypothetical design, participants are first given outcome information and then are asked to ignore the outcome and make the predictive judgment as they would have made had they

not learned the outcome. In this design, retrospective judgments are compared between-subjects with a group that had made a predictive judgment without outcome information. As mentioned earlier, while the within-subjects design of this experiment and the between subjects design of Nestler and Egloss (2009) produced similar hindsight patterns for surprising outcome likelihood judgments, future research needs to examine if the hindsight patterns of the confidence ratings as well as the unsurprising outcome likelihood judgments demonstrated in this experiment generalize to a between subjects design.

The results from this investigation support a non-unitary approach to understanding and investigating the hindsight bias phenomenon that integrates ideas across different literatures and can help explain some of the inconsistencies and anomalies in the hindsight bias literature. These findings can be used to build upon the great theoretical advancements in the field to date and offer potentially fruitful research directions for the future. For example, this non-unitary approach is able to generate unique, testable predictions involving the representational and judgment formation differences between judgment tasks. For instance, the *Motivated Sense-Making* model developed by Pezzo et al. (2007) would predict no hindsight bias in conditions of high self-relevance conditions and hindsight bias in low self-relevance conditions, regardless of judgment type. However, this non-unitary approach would predict different patterns of hindsight bias on situational and metacognitive judgments regardless of the self-relevance of the judgment.

I believe that many of the different hindsight bias theories that have been proposed offer important insights into the causes of hindsight bias effects specifically,

and the processes by which people represent information and formulate judgments in general. Based on this proposed non-unitary approach, theories of hindsight bias that have previously been viewed as competing accounts of a single psychological phenomenon may actually prove to be complimentary explanations of retrospective judgment effects in qualitatively different domains. Based on the current investigation, sense-making theories and expectation based adjustment theories may be just two sides of the same coin; the former accounting for hindsight bias effects on situational judgments and the latter accounting for hindsight bias effects on metacognitive assessments.

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APPENDIX A

THE CHAMPIONSHIP TENNIS MATCH

Preoutcome information text: With all sentences included, this is the Equated Support version. With boldfaced sentences removed, it becomes the Krause Supporting version, and with underlined sentences removed, it becomes the Mitchell Supporting version. The story is divided into three parts. Within each part, the sentences with Krause or Mitchell as the subject were counterbalanced to control for order effects. Sentence labels: S = setting; K = Krause as subject; M = Mitchell as subject; KO = Krause outcome; MO = Mitchell outcome. Numbering reflects the proposed matched causal antecedence for each outcome.

Part 1

S1. The final tennis match of the Australian open pitted two very noteworthy players against each other.

K1. The player who was starting on the north side of the court was Mark Krause from Germany.

K2. Krause was a 39-year-old, well-respected veteran tennis player.

K3. That year, Krause had staged the comeback of the decade.

K4. In his younger years he was consistently a top ranked world champion.

K5. Krause was an experienced player who had trained hard to get back at the top of his game.

K6. His hard training had helped him move up to 5th in the international rankings.

K7. However, at his age, Krause was thought by many critics to be well past his prime.

M1. The player who was starting out on the south side of the court was Nathan Mitchell of the United Kingdom.

M2. Mitchell was a 19-year-old tennis prodigy.

M3. That year, Mitchell had been considered one of the most promising new players.

M4. At the previous year's Olympics, he had earned a gold medal in the singles competition.

M5. Mitchell was an ambitious young player who was a natural athlete.

M6. This athletic ability had led him to be ranked 6th internationally.

M7. However, many critics have pointed out that, at his age, he still lacked the experience of many of the other top ranked players.

Part 2

S2. Both players had different strengths and weaknesses.

K8. Krause was known for his rocket of a first serve.

K9. He was nicknamed "Ace," because he had been known to complete entire matches without losing a single point on his serve.

K10. Krause had developed a distinct patient style of play, where he focused on returning all volleys and waited for the opponent to make the mistake.

K11. However, this patient style sometimes worked against him, because the long matches often ended up wearing him out earlier than his younger opponents.

M8. Mitchell had been praised for his amazing two-handed backhand.

M9. His fast and accurate backhand rifled cross-court shots that even his quickest opponents had trouble returning.

M10. Mitchell was known for his aggressive style, where he would often move up to the net and quickly return each volley at high speeds and sharp angles.

M11. However, in past matches his tendency to move toward the net too early had left him unprepared for the strategic lobs and baseline shots of his more experienced opponents.

Part 3

S3. The wind was calm on the day of the match.

K12. Experts predicted the lack of wind would be a definite advantage for Krause, because there would be nothing to disrupt his legendary serves to the younger Mitchell.

S4. The weather on the day of the match was a balmy 93 degrees.

M12. Experts predicted that the hot weather would be a definite advantage for Mitchell, because the heat would surely have a greater detrimental effect on the older Krause.

S5. The match was about to begin and a hush fell over the crowd.

S6. Tennis fans around the world tuned in to see who was going to win this important match.

Outcome Krause

SO1. The championship match of the Australian Open did not disappoint the fans.

SO2. The match pitted two formidable competitors against each other.

SO3. However, in the end there could only be one champion.

KO4. At the end of the match, Mark Krause from Germany proved victorious.

KO5. Krause defeated his opponent, Nathan Mitchell of Great Britain, in a decisive victory.

KO6. Krause's fans cheered wildly as he accepted his trophy as the Champion of the Australian Open.

Outcome Mitchell

SO1. The championship match of the Australian Open did not disappoint the fans.

SO2. The match pitted two formidable competitors against each other.

SO3. However, in the end there could only be one champion.

MO4. At the end of the match, Nathan Mitchell from Great Britain proved victorious.

MO5. Mitchell defeated his opponent, Mark Krause of Germany, in a decisive victory.

MO6. Mitchell's fans cheered wildly as he accepted his trophy as the Champion of the Australian Open.

APPENDIX B

THE JOB PROMOTION

Preoutcome information text: With all sentences included, this is the Equated Support version. With boldfaced sentences removed, it becomes the Kellar Supporting version, and with underlined sentences removed, it becomes the Davidson Supporting version. The story is divided into three parts. Within each part, the sentences with Kellar or Davidson as the subject were counterbalanced to control for order effects. Sentence labels: S = setting; K = Kellar as subject; D = Davidson as subject; KO = Kellar outcome; DO = Davidson outcome. Numbering reflects the proposed matched causal antecedence for each outcome.

Part 1

- S1. The final round of interviews for a job promotion pitted two very noteworthy businessmen against each other.
- K1. The businessman who was scheduled for the morning interview was Jeffrey Kellar.
- K2. Kellar was a 64-year-old, well-respected businessman.
- K3. That year, Kellar had accomplished a marked increase in his sales profits compared to previous years.
- K4. In his younger years he was consistently a top ranked salesman.
- K5. Kellar was a savvy businessman who had worked hard to get back at the top of his game.
- K6. His hard work had helped him move up the ranks in his company's sales division.
- K7. However, at his age, Kellar was thought by many senior executives to be well past his prime.**
- D1. The businessman who was scheduled for the afternoon interview was Michael Davidson.
- D2. Davidson was a 22-year-old business prodigy.
- D3. That year, Davidson had been considered one of the most promising new associates.
- D4. During the previous year, he had earned his company's top award for exemplary job performance.**
- D5. Davidson was an ambitious young businessman who was a natural born salesman.
- D6. This ability had led him to be ranked by his supervisors as a top sales prospect.
- D7. However, many critics have pointed out that, at his age, he still lacked the experience of many of the older top ranked salesmen.

Part 2

- S2. Both businessmen had different strengths and weaknesses.
- K8. Kellar was known for his highly detailed sales pitch.
- K9. He was nicknamed "Old Faithful," because he had never lost a single customer to a rival company.

K10. Kellar had developed a distinct selling style, where he impressed his customers with his product knowledge.

K11. However, this selling style sometimes worked against him, because his customers were sometimes bored with his overly time consuming conversations.

D8. Davidson had been praised for his amazing knack at quickly closing a business deal.

D9. His fast and deliberate sale pitch consistently hit the mark, setting him apart from his less successful colleagues.

D10. Davidson was known for his aggressive business style; where he would often move on a sales deal quickly, preventing competing salesmen from presenting a counter offer.

D11. However, in the past few business deals his tendency to close the deal too quickly had lead to poor customer satisfaction ratings.

Part 3

S3. The first part of the interview consisted of a mock sales presentation to the company's executive board to illustrate the candidates' product knowledge.

K12. Colleagues predicted the presentation would be a definite advantage for Kellar, because of his extensive product knowledge.

S4. The second part of the interview consisted of brief one-on-one interviews with specific executive board members.

D12. Colleagues predicted that the brief interviews would be a definite advantage for Davidson, because the short time limit would surely have a greater detrimental effect on the overly wordy Kellar.

S5. The interview was about to begin.

S6. Colleagues from around the office gossiped as to who would get the promotion.

Outcome Kellar

SO1. The job promotion did not disappoint the employees.

SO2. The interview pitted two formidable candidates against each other.

SO3. However, in the end only one applicant could get the promotion.

KO4. At the end of the interview day, Jeffrey Kellar got the promotion.

KO5. Kellar was selected over his competition, Michael Davidson, in a unanimous decision.

KO6. Kellar's colleagues congratulated him as he graciously accepted his new promotion.

Outcome Davidson

SO1. The job promotion did not disappoint the employees.

SO2. The interview pitted two formidable candidates against each other.

SO3. However, in the end only one applicant could get the promotion.

DO4. At the end of the interview day, Michael Davidson got the promotion.

DO5. Davidson was selected over his competition, Jeffrey Kellar, in a unanimous decision.

DO6. Davidson's colleagues congratulated him as he graciously accepted his new promotion.

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