THE PERILS OF UNJUSTIFIED CONFIDENCE:

AN EXAMINATION OF CASINO BLACKJACK PLAY AND PERFORMANCE

By

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THE PERILS OF UNJUSTIFIED CONFIDENCE:

AN EXAMINATION OF CASINO BLACKJACK PLAY AND PERFORMANCE

Thesis under direction of Eric R. Stone, Ph.D., Associate Professor of Psychology, Wake Forest University.

Unjustified confidence, in particular overconfidence—whereby confidence exceeds knowledge—is one of the most robust findings in judgment and decision-making research (Plous, 1993). Further, despite little research, unjustified confidence has been presumed to produce poor decisions (e.g., Griffin & Tversky, 1992). The purpose of the present study is to explore what the perils of unjustified confidence may be. More specifically, a mediational model of unjustified confidence as a predictor of outcomes is proposed.

In the present study, first, participants' level of knowledge and related-confidence regarding casino blackjack was assessed. Then, an effective confidence manipulation either increased or decreased their mean confidence, thereby changing their level of unjustified confidence. Lastly, participants played at least 60 rounds of casino blackjack. Increased- and decreased-confidence participants demonstrated significant differences in perception of gains and losses, anxiety, risk-taking behavior, and information search and consideration, related to blackjack play and performance. Overall, the findings support the proposed model.

INTRODUCTION

People regularly and repeatedly make decisions under uncertainty. Consider the physician's judgment regarding a patient's prognosis and the patient's choice regarding treatment. Imagine the business executive's plan to launch a new product and the consumer's assessment of which product to buy. Recall the meteorologist's weather prediction and the event planner's call to move the event inside. Although all of these judgments are made under uncertainty, each is accompanied by some level of confidence. Moreover, the more extreme the confidence of the first person, the more knowledgeable he or she is perceived as being by the second person (Cutler, Penrod, & Dexter, 1990, and Fox & Walters, 1986, as cited by Bornstein & Zickafoose, 1999; Price & Stone, 2004). But, is this assumption of knowledge appropriate?

During the 2004 presidential election, Democratic presidential nominee John Kerry was frequently criticized for his uncertainty—for "flip-flopping" on issues and failing to take a "consistent position" (Fineman, Wolffe, & Lipper, 2004, p. 28). In fact, President Bush claimed, "You cannot lead if you send mixed messages" (Fineman et al., 2004, p. 24), asserting that consistency and certainty are qualities of a good leader. But, much research (e.g., Fischhoff, Slovic, & Lichtenstein, 1977; Oskamp, 1965) suggests that certainty is not always justified. As Kerry pointed out, "…you can be certain and wrong…And sometimes certainty can get you in trouble" (Fineman et al., 2004, p. 25). The purpose of this study is to explore the effects of certainty, and more specifically, the outcomes of unjustified certainty.

Unjustified Confidence in Knowledge

Interest in the appropriateness of confidence, or more broadly calibration, originated with the probability judgments of professionals (e.g., physicians and meteorologists). For

instance, consider a physician's judgment of 90% likelihood that surgery will be successful. If 9 of the 10 times that he gives this likelihood judgment surgery is successful, then the physician is appropriately confident. Similarly, a meteorologist's judgment of 30% likelihood of rain is appropriate if 3 of the 10 times she gives this likelihood judgment, it rains. Both the physician and the meteorologist are considered to be well-calibrated to the extent their probability judgments consistently match the percentage of times the event occurs (Yates, 1990).

Decades of research (e.g., Fischhoff et al., 1977; Griffin & Tversky, 1992; Koriat, Lichtenstein, & Fischhoff, 1980) have explored the calibration level of both experts and laypeople, completing both factual knowledge (e.g., "Is Absinth a precious stone or a liqueur?") and prediction tasks (e.g., forecasting stock earnings, estimating the behavior of others, or picking the winner of sports games). Unlike the physician and the meteorologist previously mentioned, most people, including experts, are not well-calibrated (e.g., Plous, 1993). That is, in most cases, confidence does not match knowledge.

The typical knowledge-confidence assessment task requires two responses. The first response is a *deterministic* judgment, which is a judgment of whether or not an event occurred or will occur, or a judgment between two or more alternatives (e.g., "Absinth is a liqueur," or "Absinth is a precious stone"). The second response is a *likelihood* judgment, which is a confidence judgment that reflects the probability of a deterministic judgment being correct. The likelihood judgment is made on a half-range response scale, ranging from 50% confidence, which reflects a complete guess, to 100% confidence, which reflects complete certainty.

Often, these tasks are designed to assess knowledge and confidence—and ultimately, calibration—within a specific content domain. An example task would be 40 items regarding nutrition. The percentage of correct deterministic judgments of these 40 items would represent knowledge of nutrition; the average of the corresponding likelihood judgments would reflect confidence in knowledge of nutrition. The *calibration* of the set of 40 deterministic and 40 likelihood judgments is determined by comparing the particular assigned probabilities to the proportions of times the deterministic judgment were correct, within a given judgment category. Perfect calibration is demonstrated when x % of the deterministic judgments that were judged x % likelihood of being correct, are indeed correct. The calibration graph (see Figure 1) depicts perfect calibration—confidence judgments are graphed along the x-axis and the percent correct of deterministic judgments are graphed along the y-axis.

For the most part, as mentioned, deterministic and likelihood judgments do not match perfectly. Rather, people demonstrate miscalibration. In particular, the most commonly reported form of miscalibration is *bias*, a difference between mean confidence and percent correct, and the most common form of bias is *overconfidence* (Plous, 1993; Winman & Juslin, 1993). Overconfidence exists when, on average, confidence is greater than percent correct. Alternatively, in rare cases, underconfidence exists when, on average, confidence is less than percent correct (refer to Figure 1 for graphical depictions of over- and underconfidence).

Thus, generally, people think that they know *more* than they actually do. One of the earliest overconfidence studies (Oskamp, 1965) revealed that "increasing feelings of confidence are not a sure sign of predictive accuracy" (p. 261). Furthermore, Fischhoff (1982) concluded that confidence tends to be 10-15% greater than percent correct on average.

Thus, confidence is frequently unjustified. This is perhaps troublesome given that one's judgments—and his or her (as well as others') subsequent actions—are based in part on a feeling of confidence in one's knowledge related to that judgment (Griffin & Tversky, 1992). Accordingly, unjustified confidence has generally been assumed to be detrimental to the quality of the decision (e.g., Griffin & Tversky, 1992; Yates, Lee, & Shinotsuka, 1996), possibly resulting in "inappropriate medical treatment, regrettable financial investments, or bad legal advice" (Griffin & Tversky, 1992, p. 432). Moreover, the leading judgment and decision making textbook states that no problem in the field is "more prevalent and potentially catastrophic than overconfidence" (Plous, 1993, p. 217).

Despite such claims, surprisingly little research has explored the effects of overconfidence, or more generally, unjustified confidence. In particular, unjustified confidence has yet to be extensively explored as a predictor either of specific behaviors or performance outcomes. Therefore, the goal of the present study is to examine unjustified confidence as a predictor of outcomes.

Unjustified Confidence as a Predictor of Outcomes

Recently, Parker (2004) and collaborators began conducting a series of studies to explore the effects of unjustified confidence on various outcome variables. Parker (2004) has utilized content domains in which he could assess knowledge and confidence. For example, a few studies (see Parker, 2004) have explored investment decision making. Specifically, Parker (2004) first assessed participants' knowledge and related-confidence of the values of stocks; a sample item included, "In the five years prior to 6/31/01, Sony (SNE) stock increased more in value (proportionately) than did the Gap (GPS)." Second, participants completed a performance task in which they created investment portfolios. In one study,

Parker (2004) found a negative relationship between unjustified confidence and investment outcome, whereby the value of the portfolios of more overconfident individuals was less than that of the less overconfident individuals; however, in a similar study they found no relationship between unjustified confidence and investment outcome. To date, Parker and colleagues have found unjustified confidence to be positively, negatively, and un-related to performance outcome.

These findings suggest that unjustified confidence may not always have the same effect on outcome. Perhaps, unjustified confidence can be advantageous or disadvantageous depending in part on the situation. Further, unjustified confidence may not always have a direct effect on performance outcome. Rather, unjustified confidence influences certain behaviors, which in turn affect the outcome. Therefore, although some (e.g., Griffin & Tversky, 1992) "doubt that the benefits of overconfidence outweigh its costs" (p. 432), the preceding research suggests that whether the benefits or costs of unjustified confidence are greater is unclear.

A Mediational Model of Unjustified Confidence as a Predictor of Outcome

To try to explain the unjustified confidence-outcome relationship, Rittmayer, Stone, and Parker (2004) have constructed a model (based, in part, on the work of Parker, 2004) whereby unjustified confidence affects a number of mediating variables, which in turn determine performance outcome. The idea is that unjustified confidence has relatively constant effects on the mediators across a range of domains, but the effects of the mediators on outcome are situation-dependent. For example, the inconsistent findings regarding the effect of unjustified confidence within the investment domain could be due, in part, to the state of the stock market: An overly confident investment portfolio manager thinks he knows

more about stocks than he actually does. Therefore, presumably, he will be more likely to invest in riskier growth-oriented stocks than would an appropriately confident manager. Now, in a bull market, such risk taking would be positive, producing profits; yet, in a bear market, risk taking would be negative, incurring losses.

To test a preliminary version of this model, Rittmayer et al. (2004) explored the relationship between unjustified confidence and casino blackjack performance. That study provided initial support for the model, finding (as predicted) unjustified confidence to be related to greater perception of gains relative to losses, less anxiety, more risk taking, and less consideration of available information.

At present, the model proposes that unjustified confidence influences a number of psychological and behavioral variables, which in turn affect performance outcome (see Figure 2). The psychological variables include perception of gains and losses and anxiety; the behavioral variables include risk-taking behavior and information search and consideration. Together, these variables explain how overconfidence affects the situation-dependent performance outcome (e.g., blackjack performance, financial investments, or medical treatment). Additionally, the current model proposes that unjustified confidence influences performance satisfaction as well.

This section of the paper describes the predicted relationships between unjustified confidence and the various mediators and outcomes, citing relevant evidence. More specifically, the following links are discussed: between unjustified confidence and the psychological mediators, between the psychological mediators and the behavioral mediators, and between the behavioral mediators and outcomes. Within each sub-section, the

determinants of the variable (i.e., the links between the named variable and those variables to the left of the named variable in the model) are discussed.

Psychological Mediators

Currently, the model proposes that unjustified confidence is related to two psychological variables: (1) perception of gains and losses and (2) anxiety.

Perception of gains and losses. Perception of gains and losses refers to the assessment of expected gains and expected losses associated with a behavior or undertaking. (Note, based on normative models of decision making, both expected gains and expected losses are comprised of expected likelihoods and utilities of the outcomes.) In other words, perception of gains and losses refers to how risky and/or beneficial a behavior is perceived to be (Weber, Blais, & Betz, 2002). For example, one individual may perceive "Investing 5% of your annual income in a very speculative stock" (Weber et al., 2002, p. 289) to be "extremely risky," whereas another individual perceives this behavior to be "not at all risky." It seems plausible that as confidence (i.e., certainty) increases, the level of risk involved should seem less. In fact, Pulford and Colman (1996) found that confidence (and therefore, overconfidence) was more inflated regarding the likelihood of positive events than of negative events. Therefore, unjustified confidence is presumed to be related to an overestimation of gains and an underestimation of losses. Thus, the overly confident individual would perceive possible gains to be greater (in terms of likelihood and severity) than possible losses.

Some research (e.g., Parker & Bjarnadóttir, 2004; Rittmayer et al., 2004) has explored a possible link between unjustified confidence and perception of gains and losses. Parker and Bjarnadóttir (2004), utilizing the college football knowledge domain, proposed that the

more overconfident the individual, the less risky he or she would perceive betting to be. Contrary to their prediction, Parker and Bjarnadóttir (2004) did not find a significant unjustified confidence-perception of risks (i.e., losses) relationship. Rather, they found, utilizing the game casino blackjack, assessed perception of gains and losses as *expectation of winning* and found that overconfident players had a greater expectation of winning. In other words, more overly confident players perceived the risk of losing money playing blackjack to be less than did more appropriately confident players. Accordingly, a negative relationship between unjustified confidence and perception of losses is predicted, and a positive relationship between unjustified confidence and perception of gains is predicted. Thus, taken together, it is predicted that overly confident individuals will perceive the gains to be greater than losses (i.e., greater positive "gains-losses differential") than will appropriately confident individuals.

Anxiety. Anxiety exists when an individual is concerned about the prospect of an undesirable event. The level of anxiety is influenced by both the degree to which the event is

well, whereby overly confident individuals will experience less anxiety during blackjack play than will appropriately confident individuals.

Behavioral Mediators

The model, at present, also includes two behavioral variables, risk taking and information search and consideration. Unjustified confidence is predicted to affect risk taking via perception of gains and losses and anxiety. Similarly, unjustified confidence is presumed to affect information search and consideration via perception of gains and losses and anxiety, as well.

Risk taking. Risk taking refers to behavior that has both potential gains and losses. Below, the possible determinants of risk taking are described.

Unjustified confidence - risk taking. Although this model proposes that unjustified confidence mainly influences risk taking via perception of gains and losses and anxiety, some research has explored only the direct unjustified confidence-risk taking link. In particular, two of the studies previously mentioned (Parker & Bjarnadóttir, 2004; Rittmayer et al., 2004) examined the unjustified confidence-risk taking link. Both studies explored the relationship between unjustified confidence and risk taking behavior, operationalized in both as the dollar amount bet—higher dollar bets indicate more risk taking, as more money is at stake to be gained or lost. Parker and Bjarnadóttir (2004) found unjustified confidence to be marginally, positively related to amount bet. Rittmayer et al. (2004) found the unjustified confidence-risk taking relationship to be fully mediated by perception of gains and losses. To sum, a positive relationship between unjustified confidence and risk taking has been found, whereby overly confident individuals were more risk taking than were appropriately confident individuals.

Perception of gains and losses - risk taking. Individuals who perceive the situation as less risky partake in more risk taking (Weber et al., 2002). Additionally, as the expected gains increase, the likelihood of engaging in the behavior increases (Weber et al., 2002). For example, Cooper, Woo, and Dunkelberg (1998) found that entrepreneurial managers, characterized for their risk-taking behavior, do not have a greater preference for losses than other managers, rather they have an overly optimistic perception of the losses involved. Weinstein (1980) suggests that being overly certain regarding the likelihood of possible events, individuals may be inclined to engage in more risky behavior, such as buying a fixer-up home and not maintaining a healthy diet. In fact, Rittmayer et al. (2004) found a strong positive relationship between perception of gains and losses and risk taking, whereby players who had a greater expectation of winning subsequently bet more per round than did those with less expectation of winning. Thus, perceiving the possible gains to outweigh the possible losses appears to lead to risky behaviors. Accordingly, a positive relationship between gains-losses differential and risk taking is predicted in this study, whereby individuals who perceive more gains (i.e., less losses) will be more risk taking than will individuals who perceive less gains (i.e., more losses).

Anxiety - risk taking. Parker (2004) suggested that heightened anxiety causes the decision maker to focus on issues irrelevant to the decision and to be overly hesitant to take action. Accordingly, increased anxiety may lead to less risk-taking behavior. Raghunathan and Pham (1999) found that anxious individuals prefer low-risk/low-reward options compared to high-risk/high-reward options. Similarly, Rittmayer et al. (2004) found a negative anxiety-risk taking relationship, whereby less anxious players were more risk taking (i.e., made larger bets on average) than were more anxious players. Therefore, a negative

anxiety-risk taking relationship is predicted in this study, whereby less anxiety will be associated with more risk taking behavior.

Information search and consideration. Information search and consideration refers to behavior that involves seeking out and utilizing additional information related to the decision. Below, the possible determinants of information search and consideration are described.

Unjustified confidence - information search and consideration. Lack of information search and consideration is frequently cited as one of the main reasons why unjustified confidence is disadvantageous (e.g., Griffin & Tversky, 1992). Presumably, overly confident individuals conduct less thorough, less systematic information searches, if they conduct them at all. Additionally, they consider available information to a lesser extent than do appropriately confident individuals. Essentially, if one is confident about his or her knowledge, what more does he or she need to know?

Several studies (e.g., Parker & Bjarnadóttir, 2004; Radecki & Jaccard, 1995; Rittmayer et al., 2004; Sieck & Arkes, 2004) have explored the relationship between unjustified confidence and information search consideration. Radecki and Jaccard (1995) investigated how perceived knowledge influences information search behavior. Perceived knowledge (i.e., ratings of "how much do you think you know?") was negatively related to information search behavior; moreover, perceived knowledge was more strongly related to information search than was actual knowledge. Other studies (e.g., Parker & Bjarnadóttir, 2004; Rittmayer et al., 2004; Sieck & Arkes, 2004) have found a similar relationship between unjustified confidence and information consideration. For example, Sieck and Arkes (2004) found that overconfident individuals exhibited less decision aid use (a specific type of information consideration) than did less overconfident individuals. Similarly, Rittmayer et al.

(2004) found that more overconfident casino blackjack players were less likely to use available "hints for blackjack play" than were less overconfident players. To sum, a negative relationship between unjustified confidence and information search and consideration has been found, whereby overly confident individuals were less likely to seek out and/or consider available information than were appropriately confident individuals.

Perception of gains and losses - information search and consideration. Presumably, if an overly confident individual feels that the possible gains are greater than the possible losses, he or she would not use additional information. Therefore, a negative perception of gains and losses-information search and consideration relationship is predicted, whereby individuals who perceive more gains (i.e., less losses) will be less likely to search for and consider information than will individuals who perceive less gains (i.e., more losses).

Anxiety - information search and consideration. An anxious individual desires uncertainty reduction (Raghunathan & Pham, 1999). Thus, it is plausible that the anxious individual would seek out and use additional information related to the decision to be made to reduce his or her uncertainty. In support of this hypothesis, Rittmayer et al. (2004) found a strong positive relationship between anxiety and information search and consideration, whereby more anxious blackjack players reported using available information ("hints for blackjack play") significantly more than did less anxious players. Therefore, a positive anxiety-information search and consideration relationship is predicted, whereby individuals who are more anxious will be more likely to search for and consider information than will individuals who are less anxious.

Outcomes

Performance outcome. According to this model, unjustified confidence influences the performance outcome via the mediators. Recall that the relationships between unjustified confidence and the mediators (see the left side of Figure 2) are assumed to be the same regardless of the situation or domain; the relationships between the mediators and the performance outcomes (see the right side of Figure 2) are assumed to be dependent on the situation or domain. Specifically, more risk taking and less information search and consideration may be either advantageous or disadvantageous to the performance outcome, depending on the circumstances. In other words, characteristics of the domain influence just how these variables affect the performance outcome.

Applying the model to casino blackjack in the present study, however, there are known relationships between the proposed behavioral mediators and performance. The following mediator-outcome relationships are predicted: Specifically, since the odds of winning in casino blackjack is less than 50%, there should be a negative relationship between risk taking (i.e., average bet) and performance outcome because each round the player is more likely to lose his or her bet than to win. Similarly, a positive relationship between information search and consideration and performance outcome is predicted because adherence to the provided suggestions for blackjack play should improve blackjack performance outcome. Therefore, in the context of casino blackjack, unjustified confidence should be negatively related to performance outcome. That is, overly confident individuals will perform worse at casino blackjack than will appropriately confident individuals.

Performance satisfaction. According to decision affect theory, confidence in an expected outcome influences one's affect (Mellers, Schwartz, Ho, & Ritov, 1997). More

specifically, the strength of an individual's confidence predicts his or her pleasure, whereby pleasure in the actual outcome is inversely related to confidence (McGraw, Mellers, & Ritov, 2004). In other words, expected successes are less pleasing than surprising successes and expected failures are less disappointing than surprising failures (McGraw et al., 2004). Therefore, assuming unjustified confidence is associated with expected successes and surprising failures, overly confident individuals should experience less pleasure and more disappointment than would appropriately confident individuals.

In support of the previous prediction, McGraw et al. (2004) assessed players' confidence regarding the likelihood of making a basketball shot prior to taking the shot, as well as their af(t)Tj 3.35994 0 Td 667 l 6Tc -.d.w (r)Tj 6.9597 l 2487.5 62.1667 l 62.4998 62.1667 l h n 0

and they subsequently played casino blackjack. This study, however, also included an experimental manipulation designed to either decrease or increase their level of confidence, so that causal relationships between unjustified confidence and outcomes could be inferred.

Additionally, the present study *marginally* attempted to explore whether the effects of unjustified confidence are really due to perceived control. Some research (e.g., Taylor & Brown, 1988, as cited by Parker & Bjarnadóttir, 2004) has equated feelings of confidence with perceived control. In particular, it has been proposed that overly confident individuals overestimate not only their knowledge but also their control of the situation (Taylor & Brown, 1988, as cited by Parker & Bjarnadóttir, 2004). Thus, perhaps perceived control, rather than unjustified confidence, is responsible for the perception of greater gains than losses and less anxiety. To explore the possible confidence-control relationship, a measure of locus of control was included.

METHOD

Participants

Participants were recruited from the introductory psychology student pool. Students who earned 50% correct or greater on the test of casino blackjack rules, which was completed during mass testing, were eligible to participate in this study. Of these students, 115 (69 males and 46 females) participated in the present study in exchange for partial fulfillment of their introductory psychology course requirements.

Measures

Test of casino blackjack rules. This test is comprised of 10 items designed to assess casino blackjack competence (i.e., familiarity with the basic rules of the game). Sample items include "How many points is a face card (King, Queen, or Jack) worth?" and "What does it mean for a player to *split* his or her hand?" Based on pilot testing, 50% correct or greater was determined to be the "acceptable competence" eligibility requirement. The test of casino blackjack rules was used successfully in previous research (Rittmayer et al., 2004) (see Appendix A).

Knowledge-confidence assessment. The goal of this questionnaire is to measure participants' knowledge and associated confidence regarding blackjack play. The knowledge-confidence assessment of casino blackjack play is comprised of 40 items covering four areas of blackjack play: hit/stand, split/not, double down/not, buy insurance/not. All items present the player's hand and the dealer's upcard and ask participants to determine the correct play "to maximize your earnings." More specifically, for each blackjack scenario, participants first judge which play (e.g., hit or stand) is correct (a deterministic judgment) and then, second, judge how confident they are that their answer is the correct choice (a

likelihood judgment) (see Appendix B for sample items). An additional, final item asks participants to estimate how many of the 40 items they answered correctly (i.e., an aggregate judgment). Two versions of the knowledge-confidence assessment were created. The knowledge-confidence assessment was also used successfully in previous research (Rittmayer et al., 2004).

Perception of gains and losses. This questionnaire, developed for this study, is comprised of four items that assess participants' perceptions of winning and losing. In particular, two items assess the likelihood and utility (i.e., pleasure) of winning and two items assess the likelihood and (dis)utility (i.e., disappointment) of losing. Perceived gains is equal to the product of the likelihood and utility of winning, whereas perceived losses is equal to the product of the likelihood and (dis)utility of losing. The overall perception of gains and losses (referred to as "gains-losses differential") is computed by subtracting perceived losses from perceived gains (i.e., positive scores reflect the perception of more gains than losses; negative scores reflect the perception of more losses than gains) (see Appendix C).

Anxiety. A modified version of the state portion of the State-Trait Anxiety Inventory (STAI-S; Spielberger, Gorsuch, & Luschene, 1970) measures participants' anxiety during blackjack play. The questionnaire consists of 20 items (e.g., "I was tense"), which participants rate according to "how you felt *while playing blackjack*, that is, *during today's experiment*" on the response scale: (1) not at all, (2) somewhat, (3) moderately so, (4) very much so. Several of these items are reverse scored. The STAI-S (not the modified version) is a widely used and consistently reliable measure of anxiety (Barnes, Harp, & Jung, 2002, as cited by Wray & Stone, 2005) (see Appendix D).

Risk taking. The measure of risk-taking behavior is the participant's average bet across the total number of rounds of blackjack played.

Information search and consideration. The primary measure of information search and consideration is the participants' use, specifically frequency and duration of consultation, of the "hints for blackjack play" (these are suggestions for play based on basic blackjack strategy; see Appendix E). Additionally, a 9-item self-report questionnaire of information search and consideration was administered after the casino blackjack play (see Appendix F).

Performance Outcome. The measure of blackjack performance outcome is the participants' total amount won or lost at the end of blackjack play.

Performance Satisfaction. After playing blackjack, participants were asked, "How do you feel about the outcome of your blackjack game?" Their responses could range from (1) disappointed to (7) pleased.

Locus of control. The Rotter Internal-External Locus of Control scale (Rotter, 1966) is a 29 forced-choice item measure designed to assess internal/external locus of control. A sample item includes, "'Many times I feel that I have little influence over the things that happen to me,' or 'It is impossible for me to believe that chance or luck plays an important role in my life.'" The Rotter Internal-External Locus of Control scale is a reliable (internal consistency coefficient, $r = .70$) and valid measure of locus of control (Robinson, Shaver, & Wrightsman, 1991; see Appendix G for more sample items).

Experimental Manipulation

Approximately half of the participants ($n = 59$) received the manipulation designed to decrease confidence; the other half ($n = 56$) received the manipulation designed to increase confidence. The decreasing and increasing confidence manipulations were conducted in a

block schedule, whereby each block consisted of both conditions. The blocks were organized so that both manipulations were conducted at an approximately equal number of morning, afternoon, and evening sessions.

Decreasing confidence. This manipulation involved providing participants with personalized feedback regarding their calibration performance. Participants' knowledge-confidence assessment responses were scored (i.e., the number of correct and incorrect responses for each confidence level were computed) and their calibration graphs were created. The experimenter then conducted a brief (approximately 2 min) one-on-one feedback session with each participant, which included an explanation of his or her calibration graph and suggestions for improvement.

In previous studies (e.g., Lichtenstein & Fischhoff, 1980; Stone & Opel, 2000) this manipulation has decreased unjustified confidence by decreasing confidence—that is, the calibration feedback leads to lower (i.e., more realistic) confidence judgments. It is important to clarify that although this manipulation is referred to as *decreasing confidence* and the goal was to *decrease* confidence, the actual purpose of the calibration feedback is to improve calibration. For the vast majority of participants (n = 51, of the 59 in this condition), to improve their calibration, they needed to decrease their confidence. However, participants were not necessarily told to decrease their confidence ratings. Rather, they were given suggestions for calibration improvement, which typically (but not always) included the suggestion to make lower confidence judgments.

At the conclusion of the one-on-one feedback session, the experimenter asked each participant to restate the calibration advice given to him or her. As mentioned, for most participants the right response was an acknowledgement of the need to be less confident.

After all participants had received the manipulation, the experimenter gave each participant his or her calibration graph to review for approximately 2 min before completing the knowledge-confidence assessment questionnaire for a second time.

Increasing confidence. This manipulation involved providing participants with blackjack content information that appeared to be helpful, but in actuality should not improve casino blackjack play. More specifically, the information was presented as a graph of "The odds of possible outcomes, depending on the player's hand" (see Figure 3). An astute blackjack player would have realized (and a few did) that this information was not *new* or *additional*—that is, anyone with a general knowledge of blackjack rules could have created the graph. However, the *helpful* information should lead participants to *believe* that they were more knowledgeable, thereby producing greater confidence but not greater knowledge (i.e., percent correct on the knowledge-confidence assessment). Previous studies have found that this technique does indeed increase confidence, thus increasing unjustified confidence (Oskamp, 1965; Stone & Opel, 2000).

The experimenter conducted a brief (approximately 2 min) one-on-one session with each participant, which included an explanation of the (blackjack information) graph and encouragement that this information should be helpful when making judgments regarding blackjack play. After the graph was explained, participants were asked if they had any questions regarding how to interpret the graph or the information presented. As in the decreasing condition, after all participants had received the increasing confidence manipulation, the experimenter gave each participant a copy of the blackjack information graph to review for approximately 2 min before completing the knowledge-confidence assessment questionnaire for a second time.

Casino Blackjack Game

A casino blackjack computer program was created for this study.[1] The program is a standard one-player casino blackjack computer game. All players started with $5,000. Each round, the player was first asked to place a bet. Second, the dealer's upcard was displayed on the left-side of the screen and the player's hand was displayed on the right-side of the screen. Next, the player was prompted for his or her play (e.g., hit or stand) and responded by pressing the appropriate letter key. After the player's turn, the dealer played. At the end of the round, the player was told how much money he or she won/lost that round (see Figure 4). Then, to start the next round, how much money the player currently had was stated and he or she was asked to place a bet for that round. Additionally, "blackjack hints" were available for the player to view at any time during play (see Appendix E). The program recorded a number of game statistics, including time and number of rounds and hands played; number of hands won, lost, and pushed; minimum, maximum, and average bets; frequency and duration of viewing of blackjack hints; number of correct and incorrect play decisions (according to basic strategy rules); number of times hit and stand between 12 and 16, number of times split, and number of times doubled down. The cards dealt and details of play were also recorded for each round. Prior to actual play, players played five practice rounds, which were not recorded.

Procedure

The experiment was conducted with groups of six (or fewer) participants and took approximately two hours to complete. Each group was assigned to one of two experimental conditions (i.e., decreasing or increasing confidence). Although there was the potential for

[1] Many thanks to Rob Swiston for creating the casino blackjack program. The program was an invaluable contribution to this study—improving not only the quality of the data collected, but also the logistics—and is greatly appreciated.

unintentional experimenter bias, as well as the violation of independent observations, the logistic ease and benefits of this design outweighed these concerns. Moreover, careful attention was paid to prevent any possible group confounds.

Upon arriving at the experiment, participants read and signed the consent form and were given an overview of the experimental session. The experimenter first gave a short lecture (approximately 4 min) on casino blackjack rules to ensure that all participants were familiar with certain concepts of the game (e.g., doubling down, buying insurance, rules that constrain the dealer's play). Following this lecture, the experimenter introduced the first task, the knowledge-confidence assessment. Two versions of the knowledge-confidence assessment were created and counter-balanced within each session so that an approximately equal number of the participants in each session got each version of the assessment first. Participants were told that the person who performed best would be rewarded with twenty dollars. (This incentive was used to encourage participants to closely attend to the task.) The "best performance" was defined as a combination of the highest percent correct and best calibration. Since appropriate confidence judgments (i.e., good calibration) were encouraged, the experimenter gave a brief lecture on the concept of calibration.

Calibration was introduced as the extent to which one's confidence in his or her answers matches the percentage of time that one's answers actually are correct. The experimenter explained how one's calibration would be determined and the concept of probability accuracy, in particular emphasizing what confidence judgments mean (e.g., a confidence judgment of 50% means the participant is just guessing and believes it is equally likely that his or her answer is correct or incorrect). The experimenter described and drew a calibration graph that depicted perfect calibration. Additionally, the experimenter described

and drew examples of poor calibration, namely overconfidence and underconfidence (see Figure 1). The purpose of this lesson was to help participants understand how to complete the knowledge-confidence assessment questionnaire.

Next, participants completed the knowledge-confidence assessment. Following this questionnaire, participants were given the locus of control scale and a filler task. While participants completed those measures, the knowledge-confidence assessment responses of participants in the decreasing confidence condition were scored (by the experimenter and a research assistant) to determine their calibration. A calibration graph[2] was created for each of these participants, which was used during the feedback session in the decreasing confidence manipulation.

Then, depending on the condition, the group of participants received either the decreasing or increasing confidence manipulation. Prior to both manipulations, all participants were told that they needed to pay attention to the forthcoming information as they would be completing the knowledge-confidence assessment questionnaire a second time. This time participants completed the version of the questionnaire that they did not previously complete. Again, they were told that the best performance, per condition, in the second round would be rewarded with twenty dollars.

After completing the second knowledge-confidence assessment, participants completed the perception of gains and losses measure. Then, the experimenter gave instructions regarding the blackjack computer program and blackjack play. In particular,

[2] The number of items answered correctly and incorrectly per each confidence judgment (e.g., 50% or 80%) was entered into an Excel spreadsheet, which created the participant's calibration graph based on these data. A problem with this program was discovered during the seventh session—if a confidence judgment was not given, the program reported that 0% of the judgments at that interval were correct, rather than omitting that rating interval from the calibration graph. Thus, in approximately 21 cases, the graph showed that participants answered 0% of the items correctly when in fact they had not made any confidence judgments of that rating interval. In the remaining four sessions, the experimenter corrected the graphs when necessary to reflect that the confidence interval had not been used.

participants were encouraged to play blackjack realistically. As incentive to do so, participants were informed that three of them, selected at random, would be rewarded with a small fraction of his or her final amount in cash. (The grand prize was 2% of the final amount; if a participant ended the game with $4000, for example, his or her grand prize would equal $80.) Each participant was then stationed at a computer at which he or she played casino blackjack for approximately 25 min.

Finally, after playing casino blackjack, participants completed the anxiety measure and a final questionnaire, which consisted of the item regarding performance satisfaction as well as the information search and consideration questionnaire. Once participants completed these questionnaires, they were thanked for their time and dismissed.

RESULTS

Preliminary Analysis

Descriptive Analysis of the Knowledge-Confidence Assessment

First, participants' initial percent correct and mean confidence were determined, by computing the percentage of the total number of knowledge (deterministic) judgments that were correct and the average of associated confidence (likelihood) judgments, respectively, reported on the first knowledge-confidence assessment. The vast majority of participants provided all 40 knowledge and 40 corresponding confidence judgments. Across the first knowledge-confidence assessment, only six deterministic judgments and 14 likelihood judgments were left blank, and across the second knowledge-confidence assessment, only two deterministic judgments and nine likelihood judgments were left blank. In those cases where judgments were not provided, the percent correct or mean confidence was determined based on the total number of judgments provided.

Initially, participants, on average, answered 62.8% of the items correctly and reported a mean confidence of 78.3%. Thus, average bias, computed as the difference between mean confidence and percent correct (thus, a positive bias score reflects overconfidence and a negative bias score reflects underconfidence), was 15.5%. Thus, as expected, by and large, participants demonstrated unjustified confidence—confidence that exceeded knowledge. In fact, only 10 of the 115 participants were underconfident, whereby their percent correct was actually greater (ranging from 2% to 12%) than their mean confidence. Also, participants' initial aggregate confidence judgment was overly confident, though to a much lesser degree than the mean of their individual-item confidence judgments. On average, participants

reported that they answered 66.7% of the 40 items correctly, producing an aggregate bias of 3.9%.

The Effect of Version and Manipulation Condition on the Knowledge-Confidence Assessment

Three repeated-measures ANOVAs were conducted to assess the effect of the version of the knowledge-confidence assessment questionnaire and the manipulation condition on percent correct, mean confidence, and bias. For each of these ANOVAs, the between-subjects factors were knowledge-confidence assessment version (i.e., was A or B completed first) and manipulation condition (decreasing or increasing), and the within-subjects factor was the round that the dependent variable was measured in—for example, round 1 mean confidence and round 2 (i.e., post-manipulation) mean confidence.

These analyses answered two questions: First, did the knowledge-confidence assessment version affect percent correct or mean confidence? In other words, was one version of the assessment more difficult, or appeared to be more difficult, than the other? Second, did the manipulation affect percent correct, mean confidence, or bias (i.e., under/overconfidence)?

The effect of the knowledge-confidence assessment version. As mentioned, two versions of the knowledge-confidence assessment were created and counter-balanced across the two conditions. The two versions were intended, and assumed, to be of equal difficulty, and as hoped, there was no main effect of version on percent correct. That is, participants did not answer significantly more questions correct on either version A (M_A = .632) or version B (M_B = .617), $F(1, 111) = .95$, $p = .33$. Additionally, there was no two-way version by condition interaction or a three-way version by condition by round interaction, both *p*s > .10. There was, however, a significant two-way interaction between version and round, $F(1, 111)$

= 5.55, p = .02, whereby participants' percent correct on version A decreased from round one (M_{A1} = .645) to round two (M_{A2} = .620) and percent correct on version B remained relatively the same from round one (M_{B1} = .611) to round two (M_{B2} = .623), across both conditions. (We have no ready explanation of this finding—perhaps it is due to participants' scoring comparatively well (M_{A1} = .645) on version A during round one, which is presumably due to chance.)

There was no main effect of version on confidence. That is, participants' mean confidence did not differ significantly between versions A (M_A = .772) and B (M_B = .764), $F(1, 111) = .47$, p = .49. Additionally, there were no significant two-way interactions between version and condition or version and round nor was there a significant three-way interaction between version, condition, and round, all ps > .10. Thus, the version of the knowledge-confidence assessment had no effect on mean confidence. Because only one of these eight tests was significant, and it was non-interpretable, version of the knowledge-confidence assessment was concluded to have had no effect on percent correct or confidence.

The effect of the manipulation condition. Since the goal of the manipulation was to influence confidence without affecting percent correct, whether or not the manipulation influenced percent correct was examined first. There was a marginally significant main effect of condition, $F(1, 111) = 3.69$, p = .06, suggesting that percent correct did slightly differ between the two conditions. In particular, the descriptive trend revealed that participants in the decreasing condition scored a higher percentage correct (M_D = .638) than did those in the increasing condition (M_I = .611). Note that this marginal relationship is in the opposition direction of what we were concerned about, that the increasing confidence manipulation would increase percent correct. However, there was not a significant main

effect of round, $F(1, 111) = .81$, $p = .37$, suggesting that percent correct did not change from round 1 ($M_1 = .628$) to round 2 ($M_2 = .621$). Lastly, the two-way condition by round interaction was not significant, $F(1, 111) = 1.34$, $p = .25$. Thus, the manipulation condition did not significantly affect the percentage of questions answered correctly in round 2 (see Table 1 for means by condition and round).

Second, the effect of the manipulation on confidence was examined. Recall that the intention of the manipulation was to change confidence. Accordingly, it was predicted that the decreasing manipulation would decrease mean confidence and that the increasing manipulation would increase mean confidence.

There was a significant main effect of round, $F(1, 111) = 39.58$, $p < .001$, whereby confidence decreased from round 1 ($M_1 = .783$) to round 2 ($M_2 = .753$). Additionally, there was a significant main effect of condition, $F(1, 111) = 8.44$, $p < .01$, whereby mean confidence was less in the decreasing condition ($M_D = .750$) than it was in the increasing condition ($M_I = .785$). Furthermore, a significant two-way round by condition interaction, $F(1, 111) = 67.06$, $p < .001$, revealed that the change in mean confidence was different for the two manipulation conditions.

To explore the nature of the round by condition interaction, two paired-samples t-tests were conducted. A one-tailed paired-samples t-test demonstrated that the decreasing confidence manipulation significantly decreased confidence from round 1 ($M_1 = .784$) to round 2 ($M_2 = .716$), $t(58) = 8.47$, $p < .001$. Thus, the decreasing confidence manipulation, the calibration training feedback, was extremely effective in reducing participants' mean confidence. Similarly, a one-tailed paired-samples t-test also demonstrated that the increasing confidence manipulation significantly increased confidence from round 1 (M_1

= .782) to round 2 (M_2 = .791), $t(55) = 1.81$, $p = .04$. Thus, the increasing manipulation, the *helpful* blackjack information, caused a slight but significant increase in participants' mean confidence (see Table 1 for means by condition and round). To sum, both the decreasing and increasing confidence manipulations did significantly affect mean confidence in the predicted directions, although the effect of the decreasing confidence manipulation was stronger than the effect of the increasing confidence manipulation.

Lastly, to ensure that the manipulation affected bias (i.e., under/overconfidence) in the same manner that it affected confidence, the effect of the manipulation condition on bias was analyzed. There was a significant main effect of round, $F(1, 111) = 5.76$, $p = .02$, whereby bias decreased from round 1 (M_1 = .155) to round 2 (M_2 = .131). Additionally, there was a significant main effect of condition, $F(1, 111) = 15.65$, $p < .001$, whereby bias was less in the decreasing confidence condition (M_D = .112) than it was in the increasing confidence condition (M_I = .177). Furthermore, a significant two-way round by condition interaction, $F(1, 111) = 25.31$, $p < .001$, revealed that the change in bias was different for the two manipulation conditions.

Again, to explore the nature of this round by condition interaction, two paired-samples t-tests were conducted. A one-tailed paired-samples t-test demonstrated that the decreasing confidence manipulation did significantly decrease bias from round 1 (M_1 = .147) to round 2 (M_2 = .077), $t(58) = 4.27$, $p < .001$. Similarly, a one-tailed paired-samples t-test also demonstrated that the increasing confidence manipulation did significantly increase bias from round 1 (M_1 = .164) to round 2 (M_2 = .189), $t(55) = 2.36$, $p = .01$ (see Table 1 for means by condition and round). To sum, the decreasing and increasing confidence manipulations were effective, decreasing or increasing bias, respectively.

The effect of version and manipulation condition on aggregate confidence. Additionally, a repeated-measures ANOVA was conducted to test the effect of the knowledge-confidence assessment version and manipulation condition on aggregate confidence. Recall that aggregate confidence refers to how many of the 40 items participants thought they answered correctly. First, there was not a significant main effect of version, $F(1, 110) = 0.68$, $p = .41$, suggesting that aggregate confidence did not differ significantly between the two knowledge-confidence assessment versions. Similarly, there was not a significant main effect of round, $F(1, 110) = 3.15$, $p = .08$, suggesting that aggregate confidence did not change from round 1 to round 2. Also, there was not a significant main effect of condition, $F(1, 110) = 1.72$, $p = .19$, suggesting that aggregate confidence did not differ significantly between the two conditions. Likewise, there were no two-way interactions between version and condition or version and round nor was there a significant three-way interaction between version, condition, and round, all ps $> .40$.

However, there was a significant two-way round by condition interaction, $F(1, 110) = 15.99$, $p < .001$, revealing that the change in aggregate confidence was different for the two manipulation conditions. To explore the nature of the round by condition interaction, two paired-samples t-tests were conducted. A one-tailed paired-samples t-test demonstrated that the decreasing confidence manipulation marginally decreased aggregate confidence from round 1 ($M_1 = .671$) to round 2 ($M_2 = .651$), $t(57) = 1.47$, $p = .07$. However, a one-tailed paired-samples t-test demonstrated that the increasing confidence manipulation significantly increased aggregate confidence from round 1 ($M_1 = .662$) to round 2 ($M_2 = .715$), $t(55) = 4.44$, $p < .001$. Interestingly, opposite of the effect of the manipulation on mean confidence, the

increasing confidence manipulation had a stronger effect on aggregate confidence than did the decreasing confidence manipulation (see Table 1 for means by condition and round).

Analysis of the Model of Unjustified Confidence as a Predictor

Casino Blackjack Descriptive Analysis

Casino blackjack data was collected from 115 participants. One participant's blackjack data was not included (due to an error in the computer program). On average, participants played for 23 min (*sd* = 4; range 8 to 30 min), with the majority of participants (*n* = 88) playing 25 min or more. The decreasing confidence manipulation took longer on average than did the increasing confidence manipulation, creating an unforeseen confound, whereby participants in the decreasing confidence manipulation condition (*M* = 21.7 min) played for significantly less time than did participants in the increasing confidence manipulation condition (*M* = 24.9 min), $t(111) = 4.23$, $p < .001$. Therefore, on average, decreased-confidence participants (*M* = 110.8) played significantly fewer rounds of blackjack than did increased-confidence participants (*M* = 141.5), $t(112) = 3.96$, $p < .001$. Furthermore, due to the decreasing confidence manipulation taking longer than it did on average in a couple of sessions (e.g., due to computer problems), some participants in this condition played for considerably less than 25 min. Consequently, these participants played substantially fewer rounds of blackjack, and therefore had fewer opportunities to place bets, to consult the blackjack hints, etc.

To address the effect of this confound, two steps were taken. First, participants who played fewer than 60 rounds of blackjack (*n* = 7), which was one-and-a-half standard deviations below the mean number of rounds played (*M* = 126), were excluded from the analysis. Overall, excluding these seven participants from the analysis had little effect on the

results and there were no qualitative differences. Additionally, excluding these participants had the added advantage of ensuring that all of the remaining results were based on a reasonably large amount of data (i.e., 120-plus rounds), and therefore fairly reliable. Second, for all blackjack behavioral variables (with exception of the information search and consideration measures) the average was computed (e.g., the amount won/lost per round), thereby controlling for the number of rounds played. All told, the blackjack data of 107 participants were analyzed.

Of these 107 participants, the average participant played 131 rounds (range 60 to 210) of casino blackjack over 24 min (range 10 to 30 min). More specifically, he or she played 133 hands (*sd* = 42; range 60 to 233), winning 55 of those hands, losing 66 hands, and pushing 12 hands. The average participant bet $63 per hand (*sd* = 29; range 9 to 100) and ended the game with $4483, a net loss of $517.

The Effect of the Manipulation Condition on the Casino Blackjack Variables

As stated, the decreasing and increasing confidence manipulations significantly changed mean confidence. It was expected, in turn, that the differences in mean confidence (i.e., the changes in mean confidence due to the manipulation) would result in differences in the psychological, behavioral, and outcome variables. In other words, that changed confidence would produce between-condition differences in each of these variables. One-tailed independent-samples t-tests were conducted to explore any differences between the conditions (see Table 2 for psychological and behavioral variable means by condition).

Perception of gains and losses. Participants in both conditions assessed perceived gains to be greater than perceived losses, as indicated by the positive value of the gains-losses differential. Nonetheless, the increased-confidence participants found this differential

to be significantly greater (M = 1.69) than did decreased-confidence participants (M = .81), $t(105) = 3.55$, $p < .001$. More specifically, increased-confidence participants perceived the likelihood of winning (M = .54) to be greater than did decreased-confidence participants (M = .48), $t(105) = 2.00$, $p = .03$. However (though the means are in the correct direction), increased-confidence participants did not expect winning to be significantly more pleasing (M = 5.6) than did decreased-confidence participants (M = 5.4), $t(105) = 1.16$, $p = .13$. However, in moderate support of the prediction, increased-confidence participants did expect losing to be marginally less disappointing (M = 2.9) than did decreased-confidence participants (M = 3.4), $t(105) = 1.55$, $p = .06$.

Anxiety. The anxiety score was calculated by computing the mean of the 20 STAI-S items. Four participants did not complete all 20 items and therefore were not included in this analysis. A one-tailed independent-samples t-test demonstrated that, as predicted, increased-confidence participants were significantly less anxious during blackjack play (M = 1.88) than were decreased-confidence participants (M = 2.00), $t(101) = 1.81$, $p = .04$.

Risk taking. Risk taking was defined as the average bet across all hands played. A one-tailed independent-samples t-test demonstrated that, as predicted, increased-confidence participants bet significantly more per hand (M = 68.0) than did decreased-confidence participants (M = 57.8), $t(105) = 1.83$, $p = .04$.

Information search and consideration. There were two measures of information search and consideration, the blackjack program's recording of the participant's use of the hints during play and the self-report information search and consideration measure.

The first measure of information search and consideration was comprised of the total number of times and the total number of seconds that the blackjack hints were viewed.

Because both the number of times and the number of seconds viewed were positively skewed, the natural log of each (plus one, to account for the many responses equal to zero) was computed. Next, both scores were standardized (i.e., the z-score of each was calculated) and then summed to comprise the first information search and consideration score. A one-tailed independent-samples t-test demonstrated that, as predicted, increased-confidence participants utilized the hints less (M = -.37) than did decreased-confidence participants (M = .33), $t(105) = 1.85$, $p = .03$. More specifically, increased-confidence participants consulted the hints marginally fewer times (M = 4.0) than did decreased-confidence participants (M = 6.5), $t(105) = 1.39$, $p = .08$. Additionally, increased-confidence participants viewed hints for significantly less time (M = 37 s) than did decreased-confidence participants (M = 66 s), $t(105) = 1.73$, $p = .04$.

Based on a reliability analysis (Cronbach's $\alpha = .84$), the second measure of information search and consideration was comprised of four of the self-report questionnaire items (See Appendix F, items 2, 3, 6, and 7). Scores on these items were standardized and summed to comprise the second information search and consideration score. Thirteen participants did not provide responses to all four of these items; therefore, this analysis included the data of 94 participants. (Note, the two measures of information search and consideration were highly correlated, $r = .82$, $p < .001$.) Similarly, based on the self-report information search and consideration data, increased-confidence participants utilized the hints less (M = -.53) than did decreased-confidence participants (M = .60), $t(92) = 1.64$, $p = .05$.

Performance outcome. Performance outcome was analyzed in terms of both the final amount of money at the end of blackjack play and the average amount won/lost per round. A

one-tailed independent-samples t-test demonstrated that, as predicted, increased-confidence participants ended the game with less money (M = 4293) than did decreased-confidence participants (M = 4684), $t(105) = 1.86$, $p = .03$. Recall, however, that this effect could have occurred because increased-confidence participants played for longer and more rounds than did decreased-confidence participants. Therefore, we also analyzed the amount won/lost per round. A one-tailed independent-samples t-test demonstrated that increased-confidence participants lost marginally more money per round (M = -4.71) than did decreased-confidence participants (M = -2.05), $t(105) = 1.51$, $p = .07$ (see Table 2 for blackjack outcome means by condition).

Performance satisfaction. Performance satisfaction was defined as the post-blackjack play rating of feelings about the blackjack performance outcome. Responses ranged from disappointed (1) to pleased (7). The average rating was neutral (M = 4.2), but most participants felt slightly disappointed or slightly pleased (i.e., gave ratings of 3 or 5, respectively) about the outcome. Although a significant difference in performance satisfaction was predicted, a one-tailed independent-samples t-test demonstrated that increased-confidence participants (M = 4.0) were not significantly less pleased with their blackjack performance than were decreased-confidence participants (M = 4.4), $t(105) = 1.20$, $p = .12$ (see Table 2 for blackjack outcome means by condition).

Correlational Analysis of the Relationships between the Mediating Variables and Outcomes

In this section, first, the zero-order correlations between the mediating psychological and behavioral variables are presented. Second, the zero-order correlations between the behavioral mediators and the outcome variables are presented. (Note for all correlations, one-tailed p-values are reported.)

Correlations between the psychological and behavioral variables. Greater perception of gains than losses (i.e., gains-losses differential) was marginally associated with greater risk-taking behavior (i.e., higher average bets), $r = .15$, $p = .06$, giving slight support to the prediction. Additionally, one component of gains-losses differential, perception of losses was associated with less risk-taking behavior, $r = -.16$, $p = .05$. That is, the greater players perceived the losses to be, the less money they bet per round. No other components of the gains-losses differential were significantly related to risk-taking behavior, all *p*s > .10. Also as predicted, anxiety was associated with less risk-taking behavior, $r = -.16$, $p = .05$.

Contrary to the prediction, gains-losses differential was not significantly associated with less information search and consideration, in terms of both the use of the blackjack hints, $r = -.09$, $p = .18$, and self-reported information search and consideration, $r = -.12$, $p = .23$. Likewise, for both measures, no other components of gains-losses differential were significantly related to information search and consideration, all *p*s > .20. Also contrary to the prediction, anxiety was not significantly associated with greater use of the blackjack hints, $r = .07$, $p = .24$, or greater self-reported information search and consideration, $r = .15$, $p = .14$ (see Table 3 for the psychological-behavioral variable correlations).

Correlations between the behavioral mediators and outcomes. As predicted, risk-taking behavior (i.e., average bet) was associated with worse performance outcome in terms of both final amount, $r = -.29$, $p < .01$, and amount won/lost per round, $r = -.17$, $p = .04$. In other words, on average, participants who bet more per round, lost more per round and overall—true to the odds of casino blackjack. However, contrary to the prediction, information search and consideration was not associated with a better performance outcome in terms of either final amount or amount won/lost per round. More specifically, use of the

blackjack hints was unrelated to both final amount, $r = .10$, $p = .29$, and amount won/lost per round, $r = .12$, $p = .22$. Similarly, self-reported information search and consideration was unrelated to both final amount, $r = .04$, $p = .67$, and amount won/lost per round, $r = .05$, $p = .67$. Lastly, not surprisingly, risk-taking behavior was associated with less performance satisfaction, $r = -.24$, $p < .01$. As mentioned, participants who bet more money, lost more money and consequently felt worse about their blackjack performance (see Table 4 for the behavioral-outcome variable correlations).

Additional Analysis

The present study also explored whether the effects of confidence could be due to perceived control. Eight participants left one or more items blank on the locus of control measure and were thus excluded from the locus of control analysis; the data of the remaining 107 participants was analyzed. To score this measure, first, external locus of control responses were counted as "1" and internal locus of control items were counted as "0." Then, the points were summed to comprise the locus of control score, whereby higher scores reflected more external (compared to internal) locus of control. The average locus of control score was 10.6 and scores ranged from 2 to 18 (possible range was 0 to 29). Locus of control was not significantly associated with mean confidence, $r = -.09$, $p = .38$, two-tailed. Furthermore, locus of control was not significantly related to perception of gains and losses or anxiety, both ps $> .25$, two-tailed.

DISCUSSION

Consistent with research in other domains (e.g., Fischhoff et al., 1977; Griffin & Tversky, 1992), participants in this study clearly demonstrated unjustified confidence, whereby (mean) confidence in blackjack knowledge substantially exceeded actual blackjack knowledge (i.e., percent correct). Confidence (as well as unjustified confidence) was not found to be related to perceived control. In the present study, the manipulation produced a change in confidence. In particular, providing calibration feedback decreased mean confidence, whereas providing *helpful* blackjack information increased mean confidence. Furthermore, neither of these manipulations affected percent correct. Therefore, the overall effect of the manipulations on unjustified confidence (i.e., bias) was the same as their effect on mean confidence—decreased-confidence participants demonstrated more appropriate confidence (though still somewhat unjustified), whereas increased-confidence participants demonstrated greater unjustified confidence.

In turn, the confidence manipulation influenced all of the psychological and behavioral variables, as well as performance outcome (but not performance satisfaction). In other words, more appropriately confident (i.e., decreased-confidence) participants and more unjustifiably confident (i.e., increased-confidence) participants perceived and behaved differently. As predicted, greater unjustified confidence was associated with perception of greater gains than losses, less anxiety, more risk taking, and less information search and consideration. Additionally, in the context of casino blackjack, unjustified confidence was marginally associated with worse performance outcome (i.e., final amount and amount won/lost per round). Thus, generally, it appeared that more appropriate confidence is associated with better outcomes.

The results of the present study bring about two important issues that need to be addressed. First, are differences between the conditions due to differences in number of rounds played? Second, is the mediational model of unjustified confidence as a predictor supported?

Is Number of Rounds of Blackjack Played Responsible for Between-Condition Differences?

Participants in the decreasing confidence manipulation condition played for significantly less time, and thus played significantly fewer rounds, than did participants in the increasing confidence manipulation condition. Though it was true that increased-confidence participants had more opportunities to exhibit most of the behaviors, much evidence suggested that the effect of rounds played was not responsible for the between-conditions differences.

First, participants completed the perception of gains and losses questionnaire prior to playing blackjack. Thus, number of rounds played could not have affected perception of gains and losses. Next, although anxiety during blackjack play was assessed post-blackjack play, it seems unlikely that amount of time (or number of rounds) played affected reported anxiety levels. Furthermore, the results showed that increased-confidence participants, who played for more time, felt less anxious than did decreased-confidence participants, who played for less time. Assuming that, if anything, more time playing blackjack would lead to more anxiety, this difference could not have produced the observed results. Thus, the differential amount of time played does not seem to be responsible for the effects on the psychological variables.

Similarly, there is not a lot of support for the effect of number of rounds played on the behavioral variables. Risk-taking behavior was analyzed as the average bet (i.e., sum of all

bets divided by total number of rounds played), thereby controlling for number of rounds played. Additionally, information search and consideration did not appear to be influenced by number of rounds played, as (similar to the anxiety results) increased-confidence participants, who played for more time, utilized (and reported utilizing) the hints less than did decreased-confidence participants, who played for less time.

Lastly, however, the effect of number of rounds played on performance outcome is less clear. It seems likely that number of rounds played could have affected the final amount won/lost. However, the amount won/lost per round was not affected by number of rounds played.

Is There Support for the Model of Unjustified Confidence as a Predictor?

Overall, there is mixed support for the mediational model of unjustified confidence as a predictor of outcome. First, findings that support the model, primarily related to the behavioral mediator risk taking, are discussed. Second, those *links* that were not supported, primarily related to information search and consideration and performance satisfaction, and the reasons why they might not have been found, are discussed.

Support for the Model

Unjustified confidence was associated with both of the psychological variables of perception of gains and losses and anxiety. In turn, both perception of gains and losses and anxiety were related to risk taking (though not information search and consideration). Although perception of gains and losses (i.e., gains-losses differential) was associated with greater risk taking, Rittmayer et al. (2004) found a much stronger relationship between perception of gains and losses and risk-taking behavior ($p < .001$). We have no ready explanation as to why the perception of gains and losses-risk taking relationship was merely

marginal in this study. However, as in previous work (e.g., Rittmayer et al., 2004), this study found a strong anxiety-risk taking relationship. Additionally, unjustified confidence seemed to affect risk taking and information search and consideration directly as well. Furthermore, a robust relationship was found between risk taking and performance outcome. All told, the links between unjustified confidence, the two psychological mediators, risk-taking behavior, and performance outcome are fairly well-supported.

Missing Links

Primarily, two variables, information search and consideration and performance satisfaction, seem not to fit in the current model. Based on the findings in this study, adjustments to the model regarding these variables are discussed.

Information search and consideration. Although unjustified confidence was associated with less information use, neither perception of gains and losses nor anxiety was associated with information search and consideration. However, Rittmayer et al. (2004) found anxiety (though not perception of gains and losses) to be associated with more information search and consideration, $p < .001$. There are at least two reasons why the relationships between the psychological mediators and information search and consideration were not found in this study. First, over half ($n = 56$) of the participants never viewed the blackjack hints, thus it could be that there was not enough data to conclude whether the relationships exist. Second, it could be that different variables mediate the relationship between unjustified confidence and information search and consideration. For example, perceived need for information might mediate the relationship between unjustified confidence and information search and consideration, whereby overly confident individuals believe they do not need information and, in turn, do not utilize available information.

Additionally, neither use of the blackjack hints nor self-reported information search and consideration was associated with performance outcome. Rittmayer et al. (2004) also did not find a relationship between information search and consideration and performance outcome. However, in the present study, information search and consideration was associated with greater percentage of correct decisions. Specifically, utilization of the blackjack hints during play (i.e., the first measure, the composite of number of times and seconds viewed), was significantly related to higher percentage of correct decisions, $r = .43$, $p < .001$. Similarly, self-reported information search and consideration (i.e., the second measure) was also significantly related to higher percentage of correct decisions, $r = .49$, $p < .001$. Subsequently, percentage of correct decisions was associated with better performance outcome, in terms of both final amount, $r = .38$, $p < .001$, and amount won/lost per round, $r = .37$, $p < .001$. These findings suggest the addition of correct decisions to the model, as a mediator between information search and consideration and performance outcome.

Performance satisfaction. Although previous research (e.g., McGraw et al., 2004) found unjustified confidence to be associated with less performance satisfaction, the unjustified confidence-performance satisfaction relationship was not found in the present study. Perhaps this link was not supported because McGraw et al. (2004) assessed the relationship between confidence in *ability* (i.e., the likelihood of making a basketball shot) and performance satisfaction, whereas this study assessed the relationship between confidence in *knowledge* and performance satisfaction.

In a sense, perceived likelihood of winning at casino blackjack reflects confidence in ability. Further examination of performance satisfaction revealed that greater perceived

likelihood of winning (which was one component of the gains-losses differential) was marginally related to lower performance satisfaction, $r = -.17$, $p = .09$, two-tailed. Thus, this finding supports McGraw and colleagues' (2004) finding that performance-related pleasure is negatively affected by (unjustified) confidence. Additionally, though not predicted, risk-taking behavior was significantly associated with lower performance satisfaction, $r = -.24$, $p = .01$, two-tailed. In sum, these findings suggest that both perception of gains and losses and risk taking might, independently, mediate the unjustified confidence (in knowledge)-performance satisfaction relationship.

Future Research

Unjustified confidence is a well-documented phenomenon, yet the effects of unjustified confidence have only recently been explored. This study (building on the work of Rittmayer et al., 2004) proposed a mediational model of unjustified confidence as a predictor of outcome and found promising support for the model. Future research should further develop and test the model. For instance, other psychological (e.g., perceived need for information) and behavioral variables could be included (see Figure 5).

As mentioned, the context of casino blackjack is useful because the relationships between the behavioral mediators and outcome are known, thus there is experimental control in a *real-world* context. To that end, future studies should ensure that playing time and number of rounds are equal between the confidence manipulation conditions. Other improvements to the present study include adjusting the calibration feedback graph to more precisely reflect confidence judgments. Additionally, a future study should ensure that participants are aware of the blackjack hints, without influencing (i.e., encouraging) their use of those hints.

Furthermore, unjustified confidence should be explored in various domains to examine whether this model explains the effects of unjustified confidence in other situations. That is, future research should test whether, as proposed, the relationships between unjustified confidence and the psychological (and perhaps, behavioral) variables are constant, regardless of the domain. If these relationships are constant, then the effects of unjustified confidence may truly be domain-dependent.

REFERENCES

Bornstein, B. H., & Zickafoose, D. J. (1999). "I know I know it, I know I saw it": The stability of the confidence-accuracy relationship across domains. *Journal of Experimental Psychology: Applied, 5*, 76-88.

Cooper, A. C., Woo, C. Y., & Dunkelberg, W. C. (1988). Entrepreneurs' perceived chances for success. *Journal of Business Venturing, 3*, 97-108.

Fineman, H., Wolffe, R., & Lipper, T. (2004, September 6). 90 minutes later, a new race. *Newsweek*, 22-28.

Fischhoff, B. (1982). Debiasing. In D. Kahneman, P. Slovic, & A. Tversky (Eds.), *Judgment under uncertainty: Heuristics and biases*. Hillsdale, NJ: Erlbaum.

Fischhoff, B., Slovic, P., & Lichtenstein, S. (1977). Knowing with certainty: The appropriateness of extreme confidence. *Journal of Experimental Psychology: Human Perception and Performance, 3*, 552-564.

Griffin, D., & Tversky, A. (1992). The weighing of evidence and the determinants of confidence. *Cognitive Psychology, 24*, 411-435.

Koriat, A., Lichtenstein, S., & Fischhoff, B. (1980). Reasons for confidence. *Journal of Experimental Psychology: Human Learning and Memory, 6*, 107-118.

Lichtenstein, S., & Fischhoff, B. (1980). Training for calibration. *Organizational Behavior and Human Performance, 26*, 149-171.

McGraw, A. P., Mellers, B. A., & Ritov, I. (2004). The affective costs of overconfidence. *Journal of Behavioral Decision Making, 17*, 1-15.

Mellers, B. A., Schwartz, A., Ho, K., & Ritov, I. (1997). Decision affect theory: Emotional reactions to the outcomes of risky options. *Psychological Science, 8*, 423-429.

Ortony, A., Clore, G. L., & Collins, A. (1988). *The cognitive structure of emotions*. Cambridge: Cambridge University Press.

Oskamp, S. (1965). Overconfidence in case-study judgments. *Journal of Consulting Psychology, 29*, 261-265.

Parker, A. M. (2004). *Calibration-as-a-predictor summary across studies*. Unpublished manuscript, Virginia Polytechnic Institute and State University.

Parker, A. M., & Bjarnadóttir, J. (2004). *Can confidence in one's knowledge predict football betting behavior?* Unpublished manuscript, Virginia Polytechnic Institute and State University.

Plous, S. (1993). *The psychology of judgment and decision making.* New York: McGraw-Hill, Inc.

Price, P. C., & Stone, E. R. (2004). Intuitive evaluation of likelihood judgment producers: Evidence for a confidence heuristic. *Journal of Behavioral Decision Making, 17*, 39-57.

Pulford, B. D., & Colman, A. M. (1996). Overconfidence, base rates and outcome positivity/negativity of predicted events. *British Journal of Psychology, 87*, 431-445.

Radecki, C. M., & Jaccard, J. (1995). Perceptions of knowledge, actual knowledge, and information search behavior. *Journal of Experimental Social Psychology, 31*, 107-138.

Raghunathan, R., & Pham, M. T. (1999). All negative moods are not equal: Motivational influences of anxiety and sadness on decision making. *Organizational Behavior and Human Decision Processes, 79*, 56-77.

Rittmayer, A. D., Stone, E. R., & Parker, A. M. (2004). *Overconfidence as an outcome predictor: Hit, stand, double down, or split.* Unpublished manuscript, Wake Forest University.

Robinson, J. P., Shaver, P. R., & Wrightsman, L. S. (1991). *Measures of personality and social psychological attitudes, 1*, 420-425. San Diego: Academic Press, Inc.

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs, 80 (1, Whole No. 609).*

Sieck, W. R., & Arkes, H. R. (2005). The recalcitrance of overconfidence and its contribution to decision aid neglect. *Journal of Behavioral Decision Making, 18*, 29-53.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Stone, E. R., & Opel, R. B. (2000). Training to improve calibration and discrimination: The effects of performance and environmental feedback. *Organizational Behavior and Human Decision Processes, 83*, 282-309.

Weber, E. U., Blais, A.-R., & Betz, N. E. (2002). A domain-specific risk-attitude scale: Measuring risk perceptions and risk behaviors. *Journal of Behavioral Decision Making, 15*, 263-290.

Weinstein, N. D. (1980). Unrealistic optimism about future life events. *Journal of Personality and Social Psychology, 39,* 806-820.

Wray, L., & Stone, E. R. (in press). The role of self-esteem and anxiety in decision making for self versus others in relationships. *Journal of Behavioral Decision Making*.

Winman, A., & Juslin, P. (1993). Calibration of sensory and cognitive judgments: Two different accounts. *Scandinavian Journal of Psychology, 34*, 135-148.

Yates, J. F. (1990). *Judgment and decision making*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Yates, J. F., Lee, J.-W., & Shinotsuka, H. (1996). Beliefs about overconfidence, including its cross-national variation. *Organizational Behavior and Human Decision Processes, 65*, 138-147.

Table 1

Knowledge-Confidence Assessment Means by Condition and Round

		Condition	
		Decreasing	Increasing
Percent Correct	Round 1	.638	.618
	Round 2	.639	.603
Mean Confidence	Round 1	.784	.782
	Round 2	.716	.791
Bias	Round 1	.147	.164
	Round 2	.077	.189
Aggregate Confidence	Round 1	.671	.662
	Round 2	.651	.715

Table 2

Psychological, Behavioral, and Outcome Variable Means by Condition

		Condition	
		Decreasing	Increasing
Perception of Gains & Losses		0.76	1.68
Anxiety		2.00	1.88
Risk-taking Behavior		59	68
Information Search & Consideration	Times hints viewed	6.5	4.0
	Seconds hints viewed	66	37
Performance Outcome	Final Amount	4684	4293
	Amount Won/Lost per Round	-2.05	-4.71
Performance Satisfaction		4.4	4.0

Note: Perception of gains and losses is the gains-losses differential, positive numbers indicate perception of greater gains than losses. Anxiety is measured on a (1) to (4) scale, where higher numbers indicate greater anxiety. Risk-taking behavior is the average amount bet per round. Performance outcome means are in dollar amounts. Performance satisfaction is measured on a (1) disappointed to (7) pleased scale.

Table 3

Correlations between Psychological Variables and Behavioral and Outcome Variables

	Behavioral Variables		Outcome Variables	
Psychological Variables	Risk Taking	Information Search & Consideration	Performance Outcome	Performance Satisfaction
Gains-Losses Differential	.15*	-.09 .12	-.10 -.07	-.17**
Perception of Gains	.08	-.03 -.10	.04 .07	-.15*
Perception of Losses	-.16**	.13 .09	.23*** .20**	.11
Likelihood of Winning	.11	-.05 -.19**	-.06 -.03	-.17**
Utility of Gains	-.02	.03 .06	.15 .14	.03
Disutility of Losses	-.12	.09 .02	.24*** .21**	.03
Anxiety	-.13*	.04 .15*	-.04 -.11	-.30***

Note: All *p*s are one-tailed values: * $.05 < p < .10$, ** $p \leq .05$, *** $p < .01$. For Information search and consideration, use of blackjack hints (i.e., measure 1) is on the left-side and self-reported use (i.e., measure 2) is on the right-side. For Performance outcome, final amount won/lost is on the left-side and amount won/lost per round is on the right-side.

Table 4

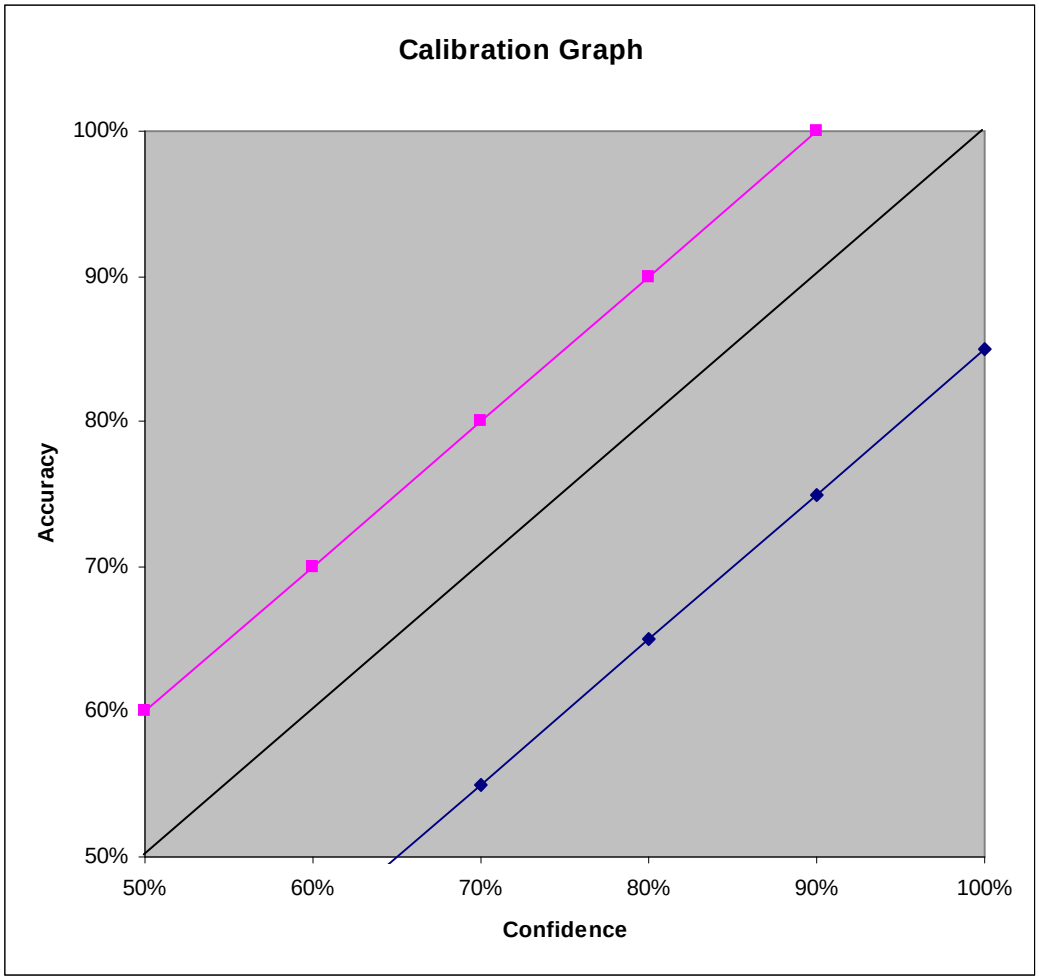
Correlations between Behavioral Variables and Outcome Variables

Behavioral Variables	Outcome Variables		
	Performance Outcome		Performance Satisfaction
Risk Taking	-.29***	-.17**	-.24***
Information Search & Consideration	.10 .04	.20 .05	.07 .02

Note: All *p*s are one-tailed values: * $.05 < p < .10$, ** $p \leq .05$, *** $p < .01$. For Information search and consideration, use of blackjack hints (i.e., measure 1) is on the top-row and self-reported use (i.e., measure 2) is on the bottom-row. For Performance outcome, final amount won/lost is on the left-side and amount won/lost per round is on the right-side.

Figure 1

Calibration Graph



Perfect calibration is reflected by the gray line.

Overconfidence is reflected by the blue line: confidence judgments are greater than the proportion of correct judgments for each respective confidence interval.

Underconfidence is reflected by the pink line: confidence judgments are less than the proportion of correct judgments for each respective confidence interval.

Figure 2

A Mediational Model of Unjustified Confidence as a Predictor of Outcome

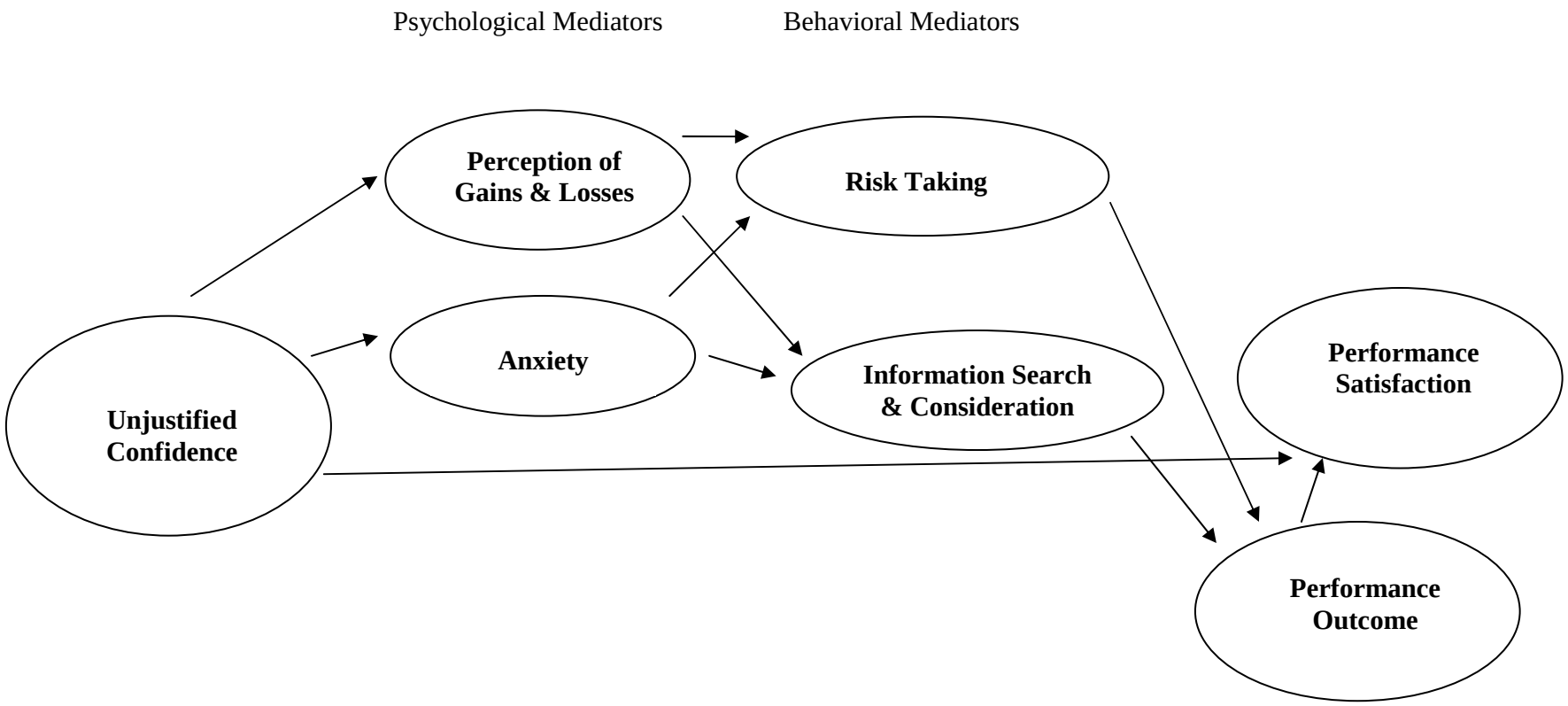


Figure 3

The Odds of Possible Outcomes, Depending on the Player's Hand

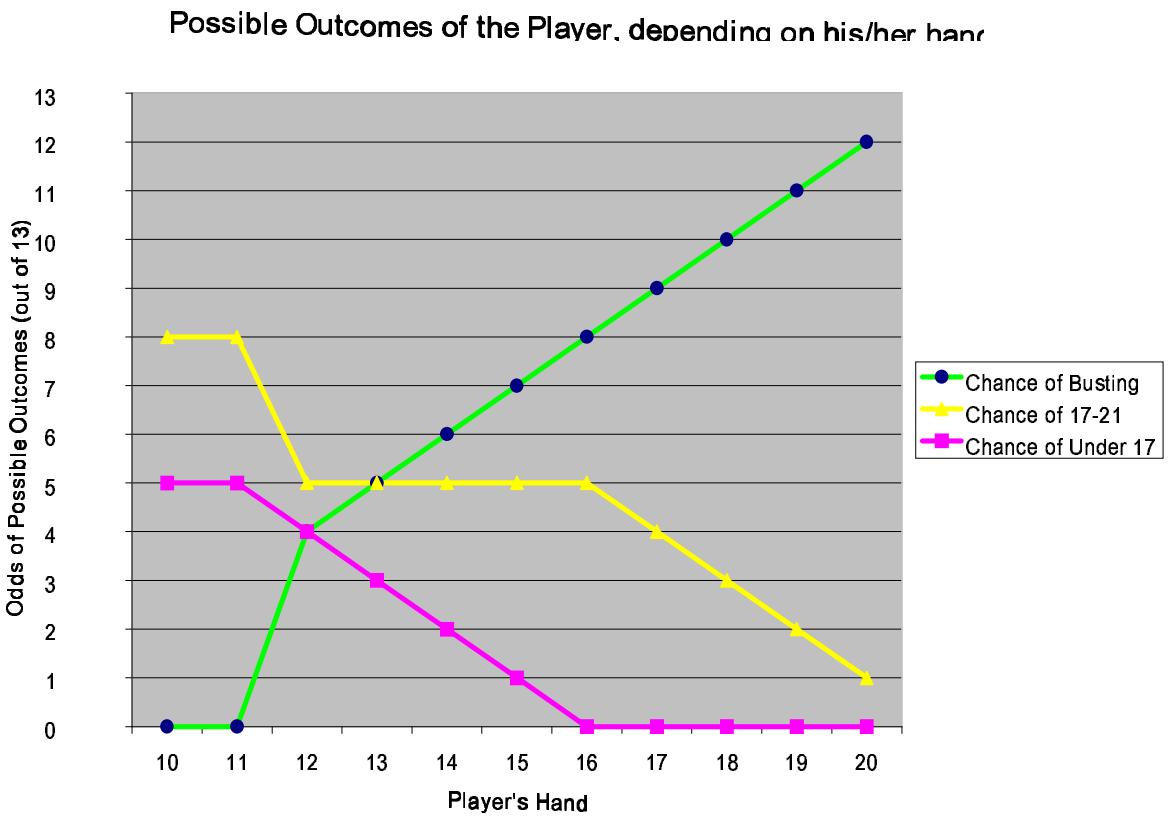


Figure 4

Casino Blackjack Program Screen

Round: 1

Dealer's hand:

Q Clubs
Q Hearts
TOTAL: 20

Hand 1: Bet $50

4 Diamonds
J Spades
Q Clubs
TOTAL: 24
*** BUSTED ***

You lost 50 dollars that round.
[OK]

(next screen)

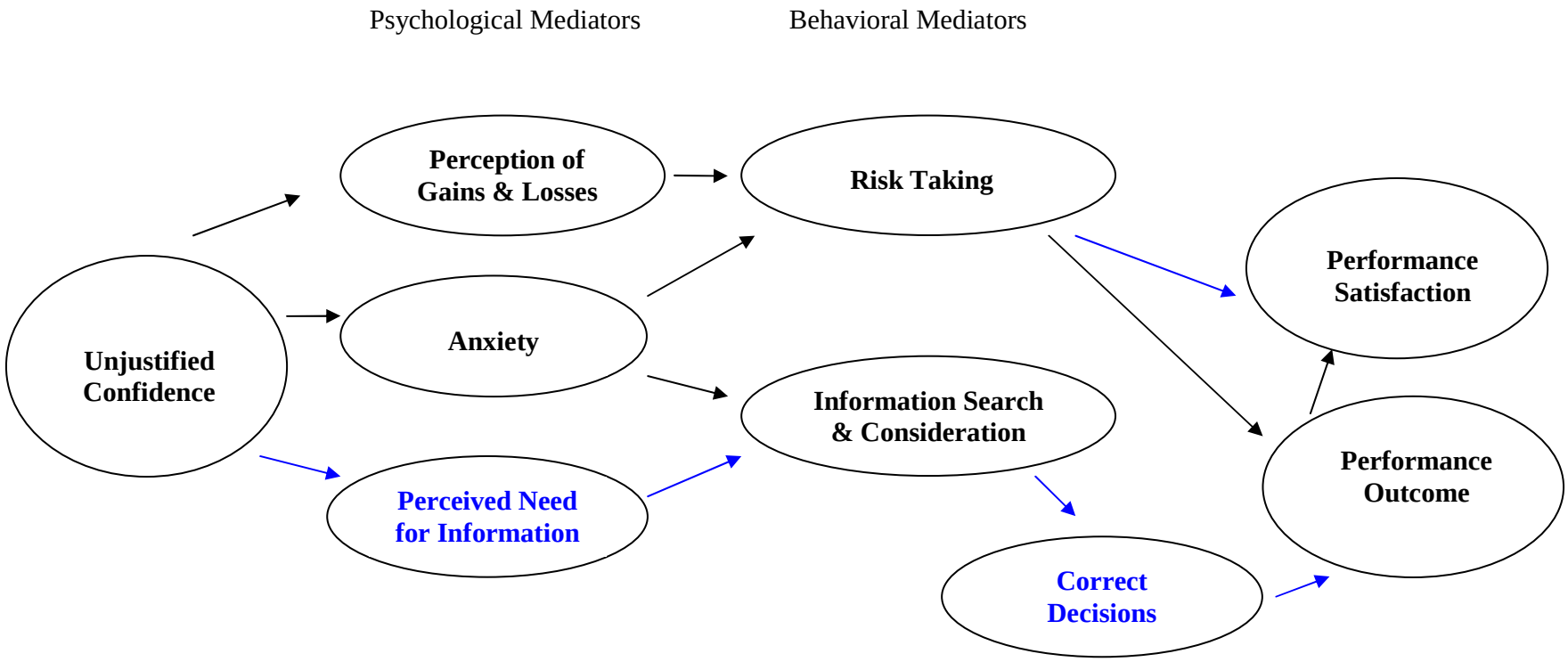
Round: 2

You currently have 4950 dollars.

Place enter an amount between 1 and 100 dollars:

Figure 5

Revised Mediational Model of Unjustified Confidence as a Predictor of Outcome



Appendix A

Test of Knowledge of Blackjack

The following are a set of questions about the game “Blackjack” as played in casinos. Please answer each of the items to the best of your ability.

1. The dealer originally deals each player how many cards?

2. The dealer’s cards are dealt:
    a. face down
    b. face up
    c. one face down, one face up

3. How many points is an Ace worth?

4. What does to “hit” mean?

5. What card combination constitutes “blackjack"?

6. How many points is a face card (King, Queen, or Jack) worth?

7. The dealer must stand if the dealer’s hand totals this many points or more:

8. What does it mean for a player to “split” his or her hand?

9. What does “double down” mean?

10. When you buy insurance, you are insuring against:
    a. the dealer getting blackjack
    b. the dealer getting 21 in any form
    c. the dealer beating you in any possible way

Appendix B

INSTRUCTIONS

This survey presents casino blackjack hands for which you must decide which of two options you should choose, such as "Hit or Stand" or "Split or Not," to maximize your earnings. "You" represents the cards in your (the player's) hand. For the "Dealer" you are shown only the dealer's upcard, though the dealer's hand includes another card that is face down. For example,

You: 3, 4 **Dealer: Q**

To maximize your earnings, should you?: Hit or Stand

We want you to do two things for each item.

First, answer the question. In this example, you might think "*Since I can't go over 21, I should hit.*" Then you would circle 'Hit.'

You: 3, 4 **Dealer: Q**

To maximize your earnings, should you?: Hit or Stand

Second, think about how sure you are of your answer. Give a number from 50% to 100%. In other words, what is the percent chance that you are right? Circle one of the numbers on the scale.

50% 60% 70% 80% 90% 100%
just guessing absolutely sure

If your answer is a total guess, circle 50%. This means that there is a 50% chance that you are right, and a 50% chance that you are wrong. If you are absolutely sure, circle 100%. If you aren't sure, then circle a number in between, to show how sure you are.

In the above example, you might think "*I am absolutely sure I should hit, so 100%*." So, you would circle 100%.

You: 3, 4 **Dealer: Q**

To maximize your earnings, should you?: Hit or Stand

50% 60% 70% 80% 90% 100%
just guessing absolutely sure

Part I: Hit or Stand

For each of these situations you will be provided with your hand and the dealer's upcard and asked whether you should hit or stand to maximize your earnings. For each item circle **Hit** or **Stand** and the probability that you are correct.

1. **You: 10, 7** **Dealer: 10**

To maximize your earnings, should you?: Hit or Stand

50% 60% 70% 80% 90% 100%
just guessing absolutely sure

2. **You: 10, 2** **Dealer: 8**

To maximize your earnings, should you?: Hit or Stand

50% 60% 70% 80% 90% 100%
just guessing absolutely sure

3. **You: 9, 5** **Dealer: 7**

To maximize your earnings, should you?: Hit or Stand

50% 60% 70% 80% 90% 100%
just guessing absolutely sure

4. **You: 10, 2** **Dealer: 7**

To maximize your earnings, should you?: Hit or Stand

50% 60% 70% 80% 90% 100%
just guessing absolutely sure

Appendix C

Initial Questionnaire

Gender: M or F

Year: Freshman Sophomore Junior Senior

The following two questions ask about your perceptions of <u>winning</u>…

1. What is the likelihood that you will ***win*** *more than you lose* during today's blackjack game?

   0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

2. How pleased would you be if you ***win*** *more than you lose* during today's blackjack game?

   1 2 3 4 5 6 7
   not at all (indifferent) moderately extremely

The following two questions ask about your perceptions of <u>losing</u>…

3. What is the likelihood that you will ***lose*** *more than you win* during today's blackjack game?

   0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. How disappointed would you be if you ***lose*** *more money than you win* during today's blackjack game?

   1 2 3 4 5 6 7
   not at all (indifferent) moderately extremely

Appendix D

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you felt *while playing blackjack*, that is, *during today's experiment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer that seems to describe the way you felt best.

Answer choices are (**1**) **not at all**, (**2**) **somewhat**, (**3**) **moderately so**, or (**4**) **very much so**.

1. I felt calm.	1	2	3	4
2. I felt secure.	1	2	3	4
3. I was tense.	1	2	3	4
4. I felt strained.	1	2	3	4
5. I felt at ease.	1	2	3	4
6. I felt upset.	1	2	3	4
7. I was worried over possible misfortunes.	1	2	3	4
8. I felt satisfied.	1	2	3	4
9. I felt frightened.	1	2	3	4
10. I felt comfortable.	1	2	3	4
11. I felt self-confident.	1	2	3	4
12. I felt nervous.	1	2	3	4
13. I was jittery.	1	2	3	4
14. I felt indecisive.	1	2	3	4
15. I was relaxed.	1	2	3	4
16. I felt content.	1	2	3	4
17. I was worried.	1	2	3	4
18. I felt confused.	1	2	3	4
19. I felt steady.	1	2	3	4
20. I felt pleasant.	1	2	3	4

Appendix E

Casino Blackjack Hints

Hit vs Stand

1. When *you* have 12-16, hit when *dealer* has a 7 or higher (7 thru ace) showing.
2. When *you* have 12-16, stand when *dealer* has a 6 or lower showing.
3. When *you* have 17 or higher, stand.

Double Down vs Hit

1. When *you* have 9-11, double down when *dealer* has a 2-6 showing.
2. When *you* have an ace and a 2, 3, 4, 5, 6, or 7, double down when *dealer* has a 5 or 6.

Split vs Don't Split

1. Always split A's and 8's.
2. Never split 5's and 10-point cards (10's, Jacks, Queens, or Kings).
3. Otherwise, split when *dealer* has a 2-6 showing.

Buying Insurance vs. Not Buying Insurance

1. Never buy insurance.

Appendix F

Final Questionnaire

Please answer the following questions regarding the blackjack game you just played…

1. How do you feel about the outcome of your blackjack game?

1	2	3	4	5	6	7
disappointed			neutral			pleased

2. How often did you look at the blackjack suggestions (i.e., use the view hints option in the blackjack game)?

1	2	3	4	5
not at all	occasionally	sometimes	quite often	very frequently

3. How often did you follow the blackjack suggestions?

1	2	3	4	5
not at all	occasionally	sometimes	quite often	very frequently

4. Did you ever change your blackjack play based on the suggestions? Yes or No
   If yes, how many times? _____

5. Did you ever disregard the blackjack suggestions? Yes or No
   If yes, how many times? _____

6. All told, how useful did you find the blackjack suggestions to be?

1	2	3	4	5	6	7
not at all useful			moderately useful			very useful

If you were to play blackjack in an actual casino….

7. Would you want to consult a book or person for additional suggestions on strategy?

1	2	3	4	5	6	7
definitely no			maybe			definitely yes

8. Would you tend to follow expert advice or rely on your intuition?

1	2	3	4	5	6	7
expert advice			both equally			solely intuition

9. What is the likelihood that you would win more money than you lose?

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Appendix G

Please read the following items carefully. For each item, circle the item that you agree with more.

1. a. Children get into trouble because their parents punish them too much.
   b. The trouble with most children nowadays is that their parents are too easy with them.

2. a. Many of the unhappy things in people's lives are partly due to bad luck.
   b. People's misfortunes result from the mistakes they make.

3. a. One of the major reasons why we have wars is because people don't take enough interest in politics.
   b. There will always be wars, no matter how hard people try to prevent them.

4. a. In the long run people get the respect they deserve in this world.
   b. Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.

5. a. The idea that teachers are unfair to students is nonsense.
   b. Most students don't realize the extent to which their grades are influenced by accidental happenings.

6. a. Without the right breaks one cannot be an effective leader.
   b. Capable people who fail to become leaders have not taken advantage of their opportunities.

7. a. No matter how hard you try some people just don't like you.
   b. People who can't get others to like them don't understand how to get along with others.

8. a. Heredity plays the major role in determining one's personality.
   b. It is one's experiences in life which determine what they're like.

9. a. I have often found that what is going to happen will happen.
   b. Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.

10. a. In the case of the well prepared student there is rarely if ever such a thing as an unfair test.
    b. Many times exam questions tend to be so unrelated to course work that studying is really useless.

Curriculum Vitae

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EDUCATION

M.A. Psychology, Wake Forest University (2005)
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B.A. Psychology and Business, Southwestern University (2001)
Graduated cum laude, GPA: 3.74, GPA in psychology: 3.96

RESEARCH EXPERIENCE

The effects of unjustified confidence.
Thesis research. Advisor: Dr. Eric Stone.
Further examination of our model of unjustified confidence as a predictor of outcome. Proposed study involves the manipulation of confidence to assess causal relationships. First-year project explored the effects of unjustified confidence in casino blackjack and provided preliminary support for our model.

Predictors of physical disablement: Overconfidence and risk perception among older adults.
Summer research project. Principal investigators: Drs.Jack Rejeski & Eric Stone; other investigators: Drs. Andy Parker & Shannon Mihalko, Jeff Katula, Alexis Rejeski, & Ashley Rittmayer.
Primarily involved with study design, including the development of measures of overconfidence regarding the disablement process and risk perception of physical disablement. Also drafted the proposal narrative for the IRB application.

An assessment of occupational stress.
Research assistant to Dr. Traci Giuliano (Spring 2000).
Thorough assessment of a county tax assessor's office; collaborated in all phases of the research, including an extensive literature review, the design and creation of a questionnaire, collection and analysis of data, and presentation of project results.

Dialing and driving.
Research assistant to Dr. Traci Giuliano (Fall 1999).
Conducted literature review of studies exploring cellular phone use while driving and contacted resources in the field regarding experiment design.

TEACHING EXPERIENCE

Teaching Assistant for Research Methods I (PSY 211), Wake Forest University (2003-present)
Prepare and teach twice weekly lab sections, primarily covering statistical analysis (e.g., correlation and regression); conduct review sessions and tutor students one-on-one outside of lab; grade exams; advise students regarding proposal paper and other assignments.

Teaching Assistant for Research Methods, Southwestern University (Fall 2000)
Duties included teaching lab sections on APA style, constructing and grading homework assignments, holding review sessions to prepare for exams, and providing feedback on paper drafts and project proposals.

PUBLICATIONS

Stone, E. R., Rittmayer, A. D., & McNiel, J. M. *Demonstrating and eliminating the aggregation effect in skill tasks*. Manuscript in preparation.

Rittmayer, A. D., Stone, E. R., & Parker, A. M. *The perils of unjustified confidence: An examination of casino blackjack play and performance.* Manuscript in preparation.

CONFERENCE PRESENTATIONS

Rittmayer, A. D., & Stone, E. R. (2004). *Examining the aggregation effect with a ping-pong toss task*. Poster presented at the 25th Annual Meeting of the Society of Judgment and Decision Making, Minneapolis.

Stone, E. R., Rittmayer, A. D., & Parker A. M. (2004). *Exploring the effects of overconfidence in casino blackjack*. Poster presented at the 25th Annual Meeting of the Society of Judgment and Decision Making, Minneapolis.

Rittmayer, A. D. (2002, October). Stressing out: An assessment of a county tax assessor's office. In T. A. Giuliano (Chair), *Working out, copping out, stressing out: Reviewing and reflecting on three student research projects conducted in Traci Giuliano's psychology lab.* Symposium conducted at Southwestern University's Alumni University, Georgetown.

Honey, M. M., & Rittmayer, A. D. (2001). *Research in social psychology: An assessment of occupational stress*. Poster presented at the 2nd Annual Southwestern University Undergraduate Research and Creative Works Symposium, Georgetown.

Rittmayer, A. D., Honey, M. M., & Giuliano T. A. (2001). *What's taxing them? An occupational stress assessment of a government office*. Poster presented at the 47th Annual Meeting of the Southwestern Psychological Association, Houston.

Rittmayer, A. D., Wilkins, T. D., & Giuliano, T. A. (2000). *The eye of the beholder: The effects of gender and sex-stereotyped occupation on perceptions of attractiveness*. Poster presented at the 46th Annual Meeting of the Southwestern Psychological Association, Dallas.

Wilkins, T. D., Rittmayer, A. D., & Senter, M. T. (1999). *Physical attraction: The effect of sex-stereotyped occupation*. Poster presented at the 10th Annual Psi Chi Student Convention, Fort Worth.

HONORS & AWARDS

2004	Wake Forest University Alumni Travel Award
2004	Wake Forest University Summer Research Fellowship
2003-2005	Wake Forest University Graduate Assistantship
2001	Southwestern University's Psychology Student of the Year
2001	Who's Who Among Students in American Universities and Colleges
2000-2001	Psi Chi Outstanding Student Research Award, Southwestern Psychological Association
1997-2001	Southwestern University Scholar (academic scholarship)

ORGANIZATIONS

2004-present	Society of Judgment & Decision Making, student affiliate
2000-2001	Southwestern Psychological Association, student affiliate
1999-2001	Psi Chi, Psychology National Honor Society (SU chapter president, 2000-2001)