May 2014

Striving for Success in an Uncertain Environment

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Striving For Success in an Uncertain Environment

by

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A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Arts
Department of Psychology
College of Arts and Sciences
University of South Florida

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Date of Approval:
March 4, 2014

Keywords: Risk, Skill, Success Rate, Uncertainty

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Abstract

Using one's success and failure experiences can be an indicator of how well risk is being managed in uncertain situations, particularly because exact probability information about outcomes is often missing. Experience-based paradigms include this more real-world aspect of a lack of information when studying risk taking behavior. This thesis builds upon experience-based paradigms to include the element of skill.

A puzzle task was developed. A goal was given to participants to try to discern a pattern in each puzzle that would yield consistently positive outcomes. Participants were randomly assigned to a high or low success rate, but told that skill played a role in performance. The outcomes associated with each puzzle were chosen by the participant, and served as a measure of risk taking. After playing 41 puzzles, participants responded to scales measuring skill and chance beliefs, and motivational focus.

Risk preferences were similar to experience-based paradigm predictions, though they were not well-calibrated. Those with a high success rate took more risks relative to those with a low success rate, but the results were less extreme than predicted. In addition, a closer look revealed that the pattern for those with a low success rate began by increasing their risk taking, and then did not decrease their risk taking significantly. Neither group felt that skill or chance was playing a dominant role in outcomes, though self-serving bias was observed as better performance did lead to higher ratings of skill. Overall, the results suggest that introducing the potential for skill may change how people approach risk in ways not predicted by experience-based paradigms.

Striving for Success in an Uncertain Environment

We are often faced with situations that are uncertain and that we need to somehow manage. Striving for success in uncertain situations provides a method for finding ways to control the situation. Our idea of skill is reliant on our ongoing observations of the interaction between uncertainty in the environment and outcomes of our attempts to be successful. To succeed, we must reduce uncertainty by detecting regularities, and then use those regularities to predict and control outcomes.

This combination of striving for success and attempting to manage uncertainty in the environment is applicable to many different contexts, including the job market (e.g, Fugate, Kinicki, & Ashforth, 2004) and academic settings (e.g., Chemers, Hu, & Garcia, 2001). Finding a job, for instance, requires facing an ever-changing economy. Students in an academic setting must handle different instructors, courses, and the transition from grade school to higher education. Former success, whether it is in the job market, an academic setting, or another context, undoubtedly influences beliefs about the role of skill which inform judgments of ability. In the case of finding a job, former success influences perceptions regarding the ability to acquire and maintain a job. Concerning school achievement, previous success influences beliefs regarding the ability to achieve a high grade or acquire a particular degree.

The success of our efforts is important to our sense of skill. However, levels of success are actually determined by a combination of skill and uncertainty in the environment. There is uncertainty in the environment whenever we are unable to determine the likelihood of possible outcomes. Dealing with this uncertainty while trying to succeed makes situations challenging. The challenge can be thought of as the attempt to control the uncertainty in the situation through skill. This thesis explores how people deal with challenging situations by applying their skill to the existing uncertainty in an attempt to succeed. Specifically, we study how general willingness to take risks is affected by one's current level of success in an uncertain environment. We also explore how level of success and risk-taking are related to inferences about the role of skill and chance, as well as tendencies to adopt a motivational focus on approaching success versus avoiding failure.

Defining and Studying Risk Taking

Risk and uncertainty go hand in hand. These concepts are studied in situations where it is unclear which outcome will occur. Knowing the probabilities of the outcomes is characteristic of a risky situation, while not knowing the probabilities of the outcomes is characteristic of an uncertain situation. The real world, however, does not clearly make this distinction between types of situations. Taking this into account, this thesis attempts to examine risk in an uncertain situation. What exactly "risk" means depends on who is asked. While a layperson might view risk as danger, psychologists and economists typically define risk as a function of variability (e.g., Arrow, 1965: Lopes, 1983). Variability has to do with the spread of the distribution of possible outcomes. The higher the variability in the situation, the greater the amount of risk. We will use the scientific definition of risk as variance when studying risk in uncertain situations.

Researchers who study risky decision making often use paradigms in which the environment is governed completely by chance, and the probabilities associated with the options are explicitly stated. One of the most common risky choice paradigms is the gambling paradigm (Lopes, 1983). In this paradigm, options are presented in a chance-driven environment as two-outcome gambles with stated probabilities. Choosing the riskier of the options is classified as risk seeking, while choosing the safer of the options is classified as risk aversion. The gambling paradigm has been used as far back as Daniel Bernoulli (1738/1954), who is considered by many to be the father of economic utility theory. It has also been the primary paradigm used to develop and test prospect theory (Kahneman & Tverky, 1979), which for more than thirty years has been the dominant theory of risky choice in the field of judgment and decision making. While this paradigm has been essential to the study of risky decision making, the paradigm is not necessarily a good fit for every kind of risky choice. The characteristics of many real world environments seem qualitatively different from what is assumed in the gambling paradigm.

For instance, people often do not have access to explicit probability information about options. Instead, the information they would have access to when making decisions would be their experiences regarding their successful and unsuccessful attempts at managing uncertainty in similar situations. Also, people are typically not operating in an entirely chance-driven environment. Instead, they are often operating in an environment in which there is the opportunity for skill to be effectively exerted to influence the likelihood of outcomes. This experiment described here is an attempt to address these two more common aspects of real world environments that the gambling paradigm does not capture.

In order to do this, a puzzle task is used in which the goal is to correctly predict a pattern in an attempt to win prizes. The task environment is one in which there is an expectation that there is the potential for skill to contribute to success in identifying a pattern. At the same time, there remains an element of uncertainty regarding the outcome of predictions. In lieu of exact probability information, experiences of success and failure at attempting to predict a pattern will be accessible to help gain a sense of the likelihood of various possible outcomes. Thus, this task will help capture two important characteristics of risk within many real world environments: (1) the potential for skill to help manage or reduce uncertainty and (2) the availability of information in the form of success and failure experiences instead of probabilities.

Actual Success Rate and Risk Taking

In an uncertain situation, we do not have access to exact probability information. Therefore, when making risky decisions, we rely on the availability of success and failure experiences. The series of success and failure experiences is used to infer one's success rate. Success rate is one of the few pieces of information available to tell us about how well we are managing risk in an uncertain situation. Several different paradigms have been used to examine the relationship between success rate and risk taking behaviors. These different paradigms sometimes incorporate aspects of the gambling paradigm and in other cases attempt to map more closely onto more common characteristics of risk in the real world. Results suggest that success rate information does influence risk preferences, and that the relationship changes depending on the information provided to the decision maker by their task environment. These types of differences have been extensively explored in what has been come to be known as the "description-experience gap" (e.g., Hertwig & Erev, 2009).

Differences in risky decision making have been studied as a function of making decisions based on descriptions of outcomes versus direct experience with outcomes (e.g., Hertwig & Erev, 2009). Making decisions from description involves using direct information regarding outcomes and their stated probabilities, as in the gambling paradigm. Making decisions from experience involves relying on feedback gained from experience with available options to learn about the likelihoods of outcomes.

Decisions about probabilities based on experience have been studied for decades, most often in the context of multiple cue probability learning (see, e.g., Brehmer, 1980; Holzworth, 2001). These investigations explore whether and how people learn correct probabilities for outcomes based on feedback. Although these studies indicate both strengths and weaknesses in people's abilities to learn from series of events, this paradigm has typically been used to study the accuracy of predictions rather than inclinations regarding risk-taking.

Barron and Erev (2003) developed a task specifically designed to examine risk-taking tendencies when choice feedback comes from experience. In this way, they could directly compare risky choice when probabilities were experienced over time versus directly supplied in a gambling-paradigm description. They created experience-based risky choices using what they told subjects was a 'computerized money machine.' In this 'computerized money machine,' there are two buttons on a computer screen, each representing a different gamble. The outcomes corresponding to the different gambles are initially unknown to the participants. Participants have the opportunity to click a button and obtain an outcome from the selected gamble. The two gambles corresponding to the two buttons are either a risky option with two possible outcomes or a safe option with a single outcome. Participants make choices in one of three types of experience-based paradigms or in the description-based paradigm.

The three variants of the task include what the authors call the *sampling, full feedback* and *partial feedback* paradigms. In the sampling paradigm, participants sample several outcomes before they make a single, final choice. In the full feedback paradigm, participants continuously receive feedback about both obtained and foregone outcomes across multiple trials. And in the partial feedback paradigm, participants continuously receive feedback across trials but only about the obtained outcomes. In several comparisons of description and experience-based risky choices, Erev, Barron, and colleagues demonstrated systematic differences in preferences (Barron & Erev, 2003; Erev et al., 2009, Hertwig & Erev, 2009).

In the experience-based paradigms, participants tended to be risk seeking when the more desirable outcome in the risk had a higher probability and tended to be risk averse when the more desirable outcome had a lower probability. For the description-based paradigm, participants generally followed the opposite pattern. Participants tended to be risk averse when the more desirable outcome had a higher probability and risk seeking when the more desirable outcome had a lower probability. Moreover, prospect theory's famous 'reflection effect' was reversed in experience-based decisions. The original reflection effect was documented in the gambling paradigm. Preferences for gambles were found to be typically risk averse for gains but risk seeking when the outcomes were 'reflected' (about the y-axis on a graph) to become losses. When comparable gambles are presented in an experience-based format, the opposite pattern emerges, with tendencies toward risk seeking for gains and risk aversion for losses. These differences in risk preferences have been termed the 'description-experience gap.'

According to Hertwig and Erev (2009), the 'description-experience gap' is caused by the way in which rare events are processed. Rare events are underweighted when making decisions from experience, but are overweighted when making decisions from description. This explanation suggests that, when decisions are made from experience, rare successes or rare failures do not hold much weight when making risky decisions. This is because rare events are, by definition, not often experienced. However, rare events remain salient in gambles wherein the probabilities are explicitly stated. When salient, these rare events are exaggerated in importance.

Research on the 'description-experience' gap provides insight into how acquiring probability information via description or experience influences risk preferences. These methods are particularly important when studying the relationship between success rate and risk taking. Decision makers can be explicitly told how well or poorly they are doing, and they can learn through their success and failure experiences. Below are examples of how different methods of acquiring probability information can influence the relationship between success rate and risk taking.

In a recent study, Schneider, Stershic and Ranieri (2013) explored the effects of repeated good or bad outcomes on risk taking. Specifically, they examined whether one was more likely to take a risk or play it safe when doing well versus poorly. Participants in this experiment saw hypothetical 50/50 two-outcome gambles, and were asked to make a selection about which gamble they preferred to play. Positive, negative and mixed experiences were created by changing whether all of the possible outcomes in the gamble were positive, negative or a mixture. The researchers found that, as participants started to have a negative experience and began doing poorly, they took more risks than they did before they started having the negative experience. Those who started to have a positive experience and began doing well took fewer risks than they did before they started having the positive experience. If people use experiences of doing well or poorly to inform them of their success rate, then these results suggest that those with a higher success rate would take fewer risks, while those with a lower success rate would take more risks.

Using hypothetical scenarios, Sitkin and Weingart (1995) found a different pattern of results. They exposed participants to a hypothetical scenario in which they had to determine if it was financially viable for their race car team to compete in the last race of their season. In this scenario, the participants were either previously successful or unsuccessful as a result of previous relevant decisions. The authors found that participants who were informed that they had successfully made similar decisions in the past reported higher levels of risk propensity (tendency to take risks) than those who were informed that they were unsuccessful. In contrast to the Schneider et al. findings, these results suggest that those with higher success rates would take more risks, while those with lower success rates would take fewer risks.

These two examples, one using a modified gambling paradigm and one using a hypothetical scenario, suggest conflicting risk preference patterns for higher and lower success rates. Sitkin and Weingart provided a description of the situation but did not give participants exact probability information, while Schneider and colleagues had participants experience a series of good or bad outcomes but did provide exact probabilities of 50/50. These differences in results suggest that the expression of probabilities may be critical to the description-experience gap. Sitkin and Weingart's lack of exact probability information led to a preference pattern similar to experience paradigms even with a description-based scenario. In contrast, the explicit probabilities in Schneider et al.'s modified gambling paradigm resulted in preferences similar to other description paradigms, even though good and bad experiences evolved over time.

Work on the description-experience gap demonstrates that the way in which we obtain information about likelihoods will influence how we feel about taking risks. Nevertheless, neither the description nor experience paradigms take into account the real-world presence of the element of skill in many situations involving uncertainty. The experience-based paradigms take the first step to map onto real world situations in which exact probability information is not available. This thesis extends these paradigms in an attempt to look at situations in which skill has the potential to be involved. We examine not only general tendencies toward taking risks, but also the extent to which people come to accurately gauge how much risk to take given information from experience about their success rate. In addition, because the experiences we are studying have the potential for skill to be involved, we also wanted to explore beliefs about skill and chance in performance.

The Role of Inferences About Skill and Chance

Interpretation of success rate information is likely to be related to the perceived role of skill and chance in real-world environments. The perceived role of skill refers to beliefs about the extent to which one is able to impart some control over the outcomes that occur. Increases in skill should be associated with increases in success rate. The perceived role of chance refers to the beliefs about the extent to which the outcomes that occur are randomly determined or the result of good or bad luck. The more that results are due to chance, the less opportunity there is to be able to exert skill to control the outcomes.

Research has been done on the influence of beliefs about skill and chance in the interpretation of a sequence of outcomes, particularly “streaks.” A streak refers to an uninterrupted series, or string, of the same outcome. Examples include research on the gambler’s fallacy and the hot hand effect, both of which deal with the interpretation of a streak in a sequence of outcomes.

The gambler's fallacy is the belief that a streak within a series of randomly determined outcomes is less likely to continue and the opposite outcome is more likely to occur. So, if a series of coin flips reveals a streak of several tails in a row, people will start to expect to see a head revealed on the next toss. That is, they will come to believe that a head is more likely than a tail to be the next outcome, even though the odds are 50/50 on every trial. This effect was first demonstrated by Laplace (1951), and has been demonstrated in actual bets placed at a casino (Croson & Sundali, 2005). Evidence was found that people bet based on belief in the gambler's fallacy. After a streak of five or more of a particular outcome, people were more likely to bet against the streak than with the streak.

The hot hand effect is a related but contrasting phenomenon in which people have the expectation that a streak of a particular outcome is likely to continue because a person is "hot." Gilovich, Vallone and Tversky (1985) demonstrated this effect within the sport of basketball. They found that people believed a basketball player to be more likely to score if they had already done so a few times in a row than if they had recently missed. The basketball player was said to have had a "hot hand," and the streak of successful shots was judged to be more likely to continue than not.

The difference between these effects lies in whether a streak of a particular outcome is expected to continue or not continue. The streak is expected to continue according to the hot hand effect, while the streak is not expected to continue according to the gambler's fallacy. This difference in expectation can make the effects seem contradictory, but this contradiction can be resolved when beliefs about skill and chance are examined.

To better understand the gambler's fallacy and hot hand effect, Ayton and Fisher (2004) studied the attributions of skill and chance that people made regarding different types of sequences. They presented participants with three sets of binary sequences. Participants were told to identify whether the sequence was an output from human skill or chance performance. The authors found that participants were more likely to attribute sequences with more streaks to human skill. Sequences with fewer streaks were found to be attributed to chance. These findings suggest that how success rate is interpreted is related to the extent to which the sequence that makes up the success rate is perceived to be a result of skill or chance. If the sequence of outcomes is consistent, then the success rate would typically be interpreted as due to high or low skill. If the sequence of outcomes is variable, then the success rate would tend to be interpreted as due to chance.

In a similar vein, Burns and Corpus (2004) studied when people would be more likely to predict a continuation of a streak of outcomes. They found that it depended on whether the mechanism generating the outcomes was believed to be random or non-random. Participants in this experiment read a hypothetical scenario about a sequence that was said to be random or non-random. They were then asked to choose which outcome they thought would occur next. The authors found that a streak was continued more often for the non-random scenarios than the random scenario. These findings have implications for how success rate information is interpreted and used. When the sequence of outcomes used to determine success rate is interpreted to be non-random (i.e., due to skill), a streak is thought to be more likely to continue.

When the sequence of outcomes used to determine success rate is interpreted to be due to chance, a streak is thought to be less likely to continue.

The results of these experiments provide evidence for the role of skill and chance in interpretation of success rate information. Whether the success rate is interpreted as a result of skill or chance depends on the consistency or variability of the sequence of outcomes. Also, whether a streak is expected to continue depends on the extent to which it is interpreted as a result of skill or chance. This is important to consider when studying the relationship between success rate and risk taking.

If success rate is interpreted as being due more to skill, then similar to the expectation in the hot hand effect, a more consistent and non-random streak would be expected to continue. The willingness to take a risk could increase for those experiencing a streak of successes because one would expect to succeed as a result of skill intervening in that risky decision. A streak of failures might also be expected to continue if skill did not seem enough to bring about successes. In this case, the willingness to take a risk could decrease because one would expect to fail and would therefore try to take the safest course possible. These patterns are similar to results from experience-based paradigms, but a difference is that hot hand research includes beliefs about skill as part of the rationale for the pattern. Thus, it should be possible to see differences in risk-taking among those with equivalent success rates depending on beliefs about the role of skill.

If success rate is interpreted as being due solely to chance, then similar to the expectation in the gambler's fallacy, a less consistent and more random streak would not be expected to continue. A streak of successes might not be expected to continue, and the opposite outcome of failure would be expected. Therefore, the willingness to take a risk could decrease because one would expect that failure is imminent, so minimizing losses would seem most important. A streak of failures might also not be expected to continue, and instead the opposite outcome of success would be expected. In this case, the willingness to take a risk could increase because one would expect that a success must be coming soon, and so going for larger potential gains would seem attractive. These predictions would not typically be expected, however, as the situation of interest is one that is believed to involve elements of both skill and chance.

The role of skill and chance is important when making risky decisions in an uncertain environment, as it has implications for how likelihoods and streaks of outcomes are interpreted and used. Related to the expectation in the hot hand effect that streaks are more likely to continue, we conduct exploratory analyses to see if patterns of risk taking varied as a function of beliefs about skill independent of success rate. We also examine beliefs about skill and chance to see if they differ as a function of success rate. We base our predictions on the well-known self-serving bias (e.g., Heider, 1958; Campbell & Sedikides, 1999). Self-serving bias is a phenomenon in which attributions made after experiencing success are different than ones made after experiencing failure. In an effort for people to enhance or protect their self-concept, experiencing success is often attributed to themselves and something they did (e.g., used their skill), while experiencing failure is attributed to the environment (e.g., chance). Exploratory analyses were also conducted to see whether motivational focus varied depending on success rate.

Exploring the Role of Motivational Focus

It is common knowledge that there exist fundamental motivations to approach pleasure and avoid pain. By the same token, we are motivated to approach success and avoid failure.

Research suggests that, not only do these motivations exist, but there are individual differences in which motivation tends to predominate. Instead of looking at individual differences in motivational focus, this thesis will explore whether experiencing a high or low success rate can direct one's motivations towards approaching the positive versus avoiding the negative.

Atkinson's (1957) theory of the motivation to achieve success versus avoid failure focused on situations that involve some skill and some chance. Atkinson demonstrated that there are individual differences in types of task chosen and willingness to take on risks, depending on the stronger motivational focus. He found that those who had a stronger motive to achieve success were willing to take on a moderate amount of risk. Those who had a stronger motive to avoid failure were willing to take on either extremely high (self-handicapping) or extremely low (ensured success) amounts of risk.

Lopes (1983) also described motivational differences, but in the context of purely chance events. SP/A theory is a two factor theory of risky choice that includes a dispositional factor that disposes people towards choosing to take a risk or to play it safe. Lopes proposed a motivational continuum in which people were predominantly motivated by security concerns or by desires for potential. Security-oriented individuals are motivated to avoid the worst outcomes in risky situations, whereas potential-oriented individuals are motivated to obtain the greatest benefit in risky situations.

Additionally, Crowe and Higgins (1997) demonstrated motivational focus differences in a memory task. They found that those with an induced promotion focus to pursue positive outcomes were more concerned with getting hits (correctly recognizing previously presented words), and therefore had a riskier bias of saying 'yes' for recognition of words. Those with an induced prevention focus to avoid negative outcomes were more concerned with getting correct rejections (correctly avoiding words that were not previously presented), and therefore had a conservative bias of saying ‘no’ for recognition of words.

Potential differences in motivational focus seem especially relevant when making risky decisions in an uncertain environment that involves skill. Although motivational focus regarding approaching success and avoiding failure are typically studied as individual differences, we hypothesized that differences in motivational focus may also occur due to experience and would be in line with experience-based paradigm predictions. When predominately experiencing successes, one may come to expect them based on skill, and therefore be more motivated to approach the positive, and take a risk. Taking the risk might be seen as worth it given that you can exert skill in order to possibly succeed as a result. When predominately experiencing failures, one may become more concerned about the inability to exert skill to avoid failures, making it more appealing to play it safe.

Aims and Hypotheses

The overall aim of this thesis is to explore how people deal with challenging situations by attempting to apply their skill to the existing uncertainty to increase their likelihood to succeed. Specifically, this thesis examined how general willingness to take on risk is affected by one’s current success rate in an uncertain environment that ostensibly involves skill. If success rate information is used in lieu of exact probabilities when making risky decisions, then different success rates are likely to elicit different risk preferences. In addition, the role of inferences about skill and chance, and differences in motivational focus are explored, as these may be related to reactions to different success rates.

Success rate and risk taking: General test of experience-based paradigm predictions. Overall, success rate was expected to influence the willingness to take on more or less risk. It was hypothesized that a low success rate would lead to a reduced willingness to take on risk. A high success rate was expected to lead to a greater willingness to take on risk. This pattern is consistent with experience-based paradigm predictions (e.g., Hertwig & Erev, 2009). This was expected because participants are not given explicit probability information and instead have to experience their successes and failures, similar to experience-based paradigms.

Success rate and risk taking: More stringent test of experience-based paradigm predictions. Additionally, how well people are calibrated in their risk taking based on their success rate was also of interest because it was a way of measuring how well people responded to success rate information. This is a more stringent test of the experience-based paradigm predictions. We expected those with a lower success rate to take on a lower level of risk compared to their optimal level of risk. In other words, they would be more risk averse than what would be optimal. This is because they are expected to underestimate the likelihood of positive outcomes because they are relatively rare. For those with a high success rate, the opposite pattern is predicted by the experience-based paradigm. They are expected to take on a higher level of risk compared to their optimal level. This is because, for them, the relatively rare events are the negative outcomes. If they underestimate the negative outcomes, they should be overconfident and relatively risk seeking.

If results go against our predictions, the description-based paradigm may provide a better fit. If this happens, results may be more consistent with prospect theory (Kahneman & Tversky, 1979) predictions. Prospect theory predicts the overestimation of relatively rare events, so that those with a low success rate are expected to overshoot their optimal level of risk and be relatively more risk seeking, while those with a high success rate should be relatively risk averse and undershoot their optimal level of risk. If these are the results, then it suggests that something other than explicit probability information may bring about the prospect theory predicted pattern.

Beliefs about skill and chance: Predictions related to hot hand. The role of inferences about skill and chance was studied in a more exploratory manner. If participants tend to attribute their performance to skill, then similar to the expectation in the hot hand effect, streaks would be expected to continue. With a high success rate, those who attribute their performance primarily to skill should take on more risk than they otherwise would because they expect their good performance to continue. With a low success rate, the opposite pattern is expected, in which attributions of skill lead to risk aversion for fear that bad performance will continue. If chance is seen as having a primary or the only role in performance, then similar to the expectation in the gambler's fallacy, streaks would not be expected to continue. Risk preference patterns opposite of those mentioned above would be predicted. Because we designed the task to appear to involve skill, these results would be unexpected.

Beliefs about skill and chance: Test of self-serving bias. We also explored overall differences in attributions of skill and chance as a function of success rate. For both conditions, it was expected that performance would be attributed more to skill than chance, particularly because skill is explained and reinforced as a factor in performance. Nevertheless, those with a high success rate are apt to believe that skill had more of a role in their performance than those with a low success rate. Those with a high success rate are also expected to believe that chance had less of a role in their performance than those with a low success rate. This is consistent with self-serving bias, in which people tend to attribute their successes to themselves and their failures to their environment (e.g., Heider, 1958; Campbell & Sedikides, 1999).

Motivational focus. Finally, we explored whether success rate is likely to influence motivational focus. Experiencing a lower success rate might focus attention on avoiding failure, so that one might be more apt to play it safe in order not to lose. Experiencing a higher success rate might focus attention on approaching success, so that one might be more willing to take a risk in order to succeed. These differences in motivational focus would be consistent with experience-based predictions of tendencies to underweight the rarer event, and might suggest an underlying role for motivation in the direction of attention (or vice versa).

Method

Participants

Two hundred and three participants were recruited for this experiment and earned psychology course extra credit for their participation. Although demographic information was not collected, the research population was likely to be consistent with undergraduate psychology majors, the majority of whom are female and between 18-24 years old.

An online system used by the psychology department (SONA) identified and recruited the potential participants. For individuals to be enrolled in the experiment, they had to be at least 18 years old and eligible to access the online system.

Materials and Stimuli

The entire experiment was conducted in a computer lab setting equipped with 11 desktop computers. This allowed multiple people to participate in the experiment at the same time. The experimental manipulation of success rate used a puzzle task in which the goal of the participant was to try, through repeated button clicks, to discern a pattern that yielded consistently positive outcomes.

At any given time, one puzzle was displayed on the computer screen. Figure 1 provides a sample of a puzzle before any button has been selected.

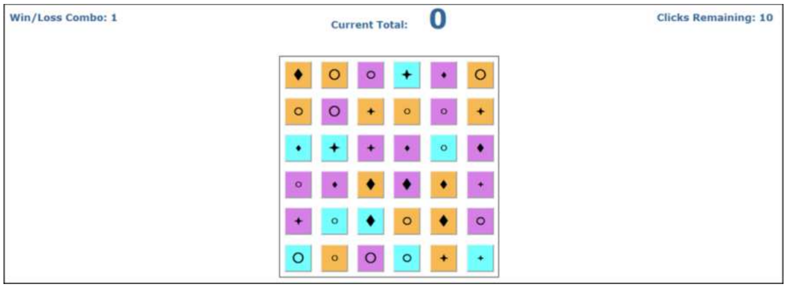


Figure 1. An example of the outset of the puzzle task. This figure illustrates a possible screen that a participant would see when starting a new 6 x 6 puzzle. In this example, the participant had chosen Win/Loss Combo 1, displayed in the upper left corner. The Current Total was displayed above the puzzle, which at the outset of each new puzzle was zero. The number in the upper right corner indicates that there were 10 clicks remaining as was always the case at the outset of each new puzzle.

Each puzzle consisted of 36 square buttons in a 6 x 6 square grid. There were three characteristics of each button that distinguished it from the other buttons in the puzzle—button color, symbol, and symbol size. Button colors, symbols, and symbol sizes were chosen to be highly distinctive within each puzzle. Nine sets of button colors and 9 sets of distinct button symbols were randomly distributed across puzzles.

To play the puzzle, the participant clicked on a button to reveal the point outcome behind the button. After a click, an outcome appeared, and was incorporated into a 'Current Total' for that puzzle trial. The outcome was either a positive 'winning' value or a negative 'losing' value. On the next click, the previous outcome disappeared leaving a blank gray space, while the currently clicked button revealed the next outcome, and so on, until the participant had clicked 10 of the 36 buttons. The number of clicks remaining ('Clicks Remaining') out of 10 was available throughout the puzzle trial on the computer screen. Once the number of clicks equaled zero, play on that particular puzzle was over, completing that puzzle trial. For an example a puzzle with three clicked buttons, see Figure 2.

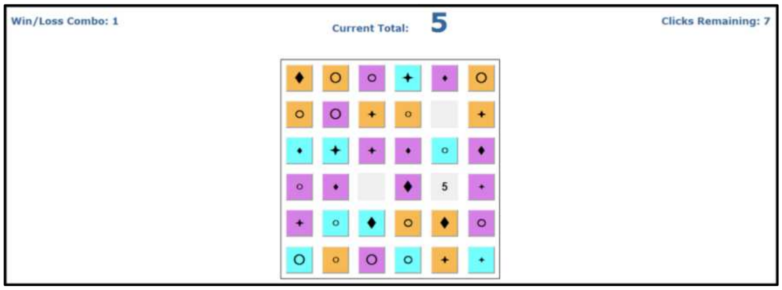
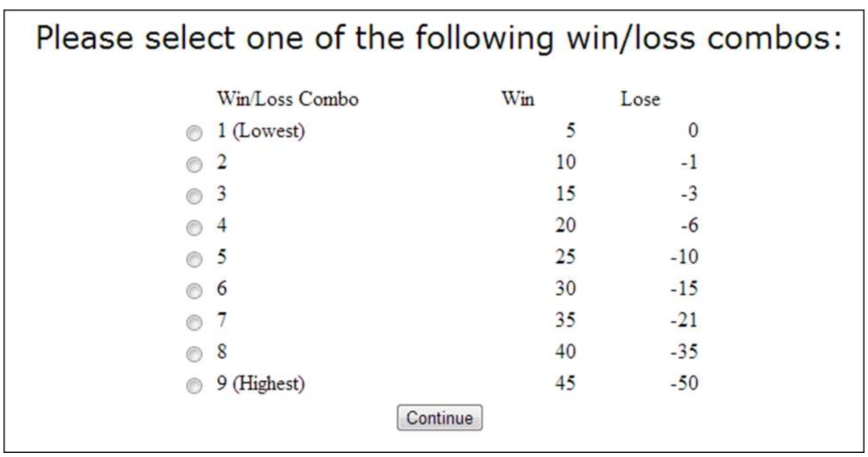


Figure 2. An example of a puzzle with three clicked buttons. This figure illustrates the same puzzle from Figure 1, but after three buttons had been clicked. A button had been clicked when the square went from colored to gray. The most recently clicked button shows a value of five, and was added onto the Current Total to increase it from zero to five.

The outcomes associated with each puzzle were determined by a previously chosen win/loss combo. There were 9 win/loss combos available, labeled Win/Loss Combo 1 through Win/Loss Combo 9. Each combo was similar to a two-outcome gamble, in that there was an associated 'winning' value and 'losing' value. As the win/loss combo level increased, the extremeness of the positive and negative outcomes increased. Decisions had to be made between safer levels with small gains but small or zero losses, and riskier levels with large potential gains but large potential losses. For an example of the win/loss combo selection screen, see Figure 3.


Please select one of the following win/loss combos:

Win/Loss Combo	Win	Lose
1 (Lowest)	5	0
2	10	-1
3	15	-3
4	20	-6
5	25	-10
6	30	-15
7	35	-21
8	40	-35
9 (Highest)	45	-50

Continue

Figure 3. An example of the win/loss combo selection screen. This screen was used to select the win/loss combo for the next two puzzles. The winning and losing values listed would be the

outcomes for clicks in the next two puzzles. After every two puzzles, participants saw this screen again and had the opportunity to choose the same or a different win/loss combo.

Each combo had an associated expected value (EV) for one click, depending on the chosen win/loss combo and the manipulated success rate. Table 1 below presents this information.

Table 1. The Expected Value of One Button Click Based on Win/Loss Combo and Success Rate

			Success Rate	
			Low	**High**
			12 out of 36 buttons	24 out of 36 buttons
			0.333	**0.667**
Win/Loss Combo	**Winning Value**	**Losing Value**		
1	**5**	**0**	1.665	3.335
2	**10**	**-1**	2.663	6.337
3	**15**	**-3**	2.994	9.006
4	**20**	**-6**	2.658	11.342
5	**25**	**-10**	1.655	13.345
6	**30**	**-15**	-0.015	15.015
7	**35**	**-21**	-2.352	16.352
8	**40**	**-35**	-10.025	15.025
9	**45**	**-50**	-18.365	13.365
Seen by participants			*Not seen by participants*	

The combo information on the left side of Table 1 outlines the win/loss combo number and the associated winning and losing values. The participant had access to this information from their win/loss combo selection screen (see Figure 3), but did not have direct access to the expected value information on the right of Table 1. The expected values in the righthand columns list the average winnings expected for one click of a button depending on the success rate. For instance, a participant with an assigned low success rate might have chosen Win/Loss Combo 2. If they did so, they would win 2.663 points for each button click *on average*. This does not mean that they would actually win 2.663 points, as they would either win 10 points or lose 1 point. Instead, the 2.663 points refers to what they would win if they clicked a random button repeatedly over the long run [$EV = .333(10) + .667(-1)$]. The highlighted expected values in the table show the combos that would result in achieving the highest expected values in each condition. The dark gray highlighting indicates the largest expected value and therefore the optimal win/loss combo for each success rate. If participants were calibrating their chosen combo to their success rate, they would ultimately select the combo that afforded them the dark gray-highlighted expected values, as these optimal win/loss combos would be expected to earn the most points. For high success rate participants, the optimal win/loss combo was Combo 7, while for low success rate participants, the optimal win/loss combo was Combo 3.

Design

The primary independent variable was a between-subjects manipulation of success rate, with participants randomly assigned to one of two levels. Success rate refers to the likelihood that the participant would get the winning value when they clicked on one button in the puzzle. The two levels of the success rate variable were low and high. This was achieved using a success rate of 33% (12 winning outcomes out of 36 buttons) and 67% (24 winning outcomes out of 36 buttons), respectively.

The primary dependent variable of interest was risk taking. Risk-taking behaviors were measured by the chosen win/loss combos. As the win/loss combos increase, risk increases. The higher the combo selected, the greater the willingness to take risk. In addition, items regarding skill, chance, and motivational focus were assessed in an exploratory manner. Satisfaction with performance and decision strategy were also assessed as a manipulation check, in that those with a high success rate should be more satisfied with their performance and decision strategy than those with a low success rate. The five ratings scales are presented in Table 2.

Table 2. Five Scale Endpoints Used to Measure Attributions, Satisfaction and Motivational Focus

Construct	Negative End of Scale	Positive End of Scale
Skill	My current total was not due to my skill.	My current total was due to my skill.
Skill	My skill had no influence over my performance.	My skill had substantial influence over my performance.
Skill	My skill is not responsible for how much I won or lost.	My skill is responsible for how much I won or lost.
Skill	My skill had nothing to do with my scores.	My skill had everything to do with my scores.
Chance/Luck	I feel that the odds were against me.	I feel that the odds were in my favor.
Chance/Luck	I was unlucky in my puzzle outcomes.	I was lucky in my puzzle outcomes.
Chance/Luck	Overall I was unlucky.	Overall I was lucky.
Chance/Luck	I feel that my scores were due to bad luck.	I feel my scores were due to good luck.
Performance Satisfaction	I feel like I did not do well.	I feel like I did well.
Performance Satisfaction	I feel like I could have done better.	I do not feel like I could have done better.
Performance Satisfaction	I expected to do better.	I expected to do worse.
Performance Satisfaction	I am not satisfied with my score.	I am satisfied with my score.
Decision Strategy Satisfaction	I am disappointed in my decision strategy.	I am proud of my decision strategy.
Decision Strategy Satisfaction	I am not happy with my decision strategy.	I am happy with my decision strategy.
Decision Strategy Satisfaction	My decision strategy was not effective.	My decision strategy was effective.
Decision Strategy Satisfaction	I feel bad about my decision strategy.	I feel good about my decision strategy.
Success/Failure Focus	I was focused on avoiding negative outcomes.	I was focused on achieving positive outcomes.
Success/Failure Focus	In this task, I mostly thought about potential failure.	In this task, I mostly thought about potential success.
Success/Failure Focus	I saw myself as striving to prevent poor performance.	I saw myself as striving to achieve good performance.
Success/Failure Focus	Mostly I imagined myself making bad puzzle button selections.	Mostly I imagined myself making good puzzle button selections.

Each of the five scales consisted of four items. Each item included possible ratings using 7 radial buttons, with the two sentences serving as opposite endpoints. Ratings were then coded as -3 to 3, to indicate going from the negative to the positive end of the scale. The four scales measuring attributions of skill and chance and satisfaction with performance and decision strategy were modified from those used in the Judgment and Decision Making lab, which are high in face validity. The fifth scale measured motivations to approach success versus avoid failure. These motivational focus items were modified from the promotion/prevention scale to be specific to the puzzle task (Lockwood, Jordan & Kunda, 2002, see also Summerville & Roese, 2008). A random sequence of all twenty items was created. Half of the items in each subscale had the negative end of the scale on the left, while the other half had the negative end of the scale on the right.

Procedure

Participants played through 41 different puzzles in the experiment. Each of these puzzles had the same underlying success rate, depending on the assigned condition. The first 10 puzzles were termed the 'Initial Skill' puzzles. This stage was used to create the illusion of the potential for skill to be involved. The next 30 puzzles were termed the 'Calibration' puzzles. This stage was used to create the opportunity for participants to calibrate their success to their environment. Afterwards, there was one final puzzle termed the 'Prize Round' puzzle. It served solely as a motivational tool for the participants to continue to pay attention while playing the puzzles. Although participants were told that their performance in this 'Prize Round' would determine the kind of prize they would receive, all participants received the same small prize no matter their performance.

Participants had the opportunity to choose a win/loss combo after every two puzzles had been completed, as well as for the 'Prize Round' puzzle, for a total of 21 choices. The first 5 choices were in the 'Initial Skill' puzzles, the next 15 win/loss combo selections were in the 'Calibration' puzzles, and the final time a win/loss combo was chosen was for the 'Prize Round.' Having participants choose win/loss combos throughout the experiment allowed for eventual analyses of risk taking over time—across 'Initial Skill' and 'Calibration' stages, as well as combo selections early and late within the stages. Details about the step-by-step procedure are outlined below.

Participants came into the laboratory and had free choice in seating. Once the session started, instructions were read and three practice puzzles were shown to the participants. Along with other information, participants were told that the purpose of this experiment was to measure “people’s general, intuitive ability to pattern match.” They were also told that rules existed that, if followed, would “help them get the winning values most of the time” and obtain a higher point total in the end. It was explained that “more points meant a better prize,” but no other specifics about the point totals and prizes were given. The first practice puzzle was used to demonstrate the task, and how different patterns could lead to a higher point total and better prize at the end of the experiment. Before the final two practice puzzles, win/loss combo levels were explained. Win/Loss Combo 1 and Win/Loss Combo 9 were used for the demonstration. In an attempt to minimize possible order effects of anchoring, sessions were randomly assigned to instructions that explained the practice puzzle with Win/Loss Combo 1 first or Win/Loss Combo 9 first. The final two practice puzzles were used to demonstrate how a chosen win/loss combo level determined the possible outcomes in the puzzle.

Participants then began the self-administered part of the session, always experiencing their assigned success rate and selecting a new win/loss combo after every two puzzles were played. They first played through the ‘Initial Skill’ puzzles. Participants were then informed of their purported skill level based on their performance in those 10 puzzles. In reality, participants were given one of two messages, depending on their assigned success rate. Those in the low success rate group were told that they were slightly below average in skill compared to others who had completed the experiment. Those in the high success rate group were told that they were above average in skill compared to others who had participated in the experiment. This information was consistent with the participant’s actual experienced performance during the manipulated ‘Initial Skill’ puzzles. Participants then played through the ‘Calibration’ puzzles. After the 30 ‘Calibration’ puzzles, the participants responded to the five exploratory scales. Finally, the participants played the puzzle in the ‘Prize Round’.

Once the self-administered part of the session was finished, the computer informed the participant that the experiment had ended. They were then instructed to see the experimenter for a debriefing sheet. At that time, they were given a small prize for completing the experiment.

Results

Analyses were conducted to examine how success rate influenced risk taking behaviors, beliefs about skill and chance, and motivational focus, as well as whether risk taking patterns were calibrated to optimal outcome levels. Dependent measures included risk taking behaviors as indicated by selected win/loss combos as well as scores on the five exploratory scales to represent related attributions, satisfaction, and motivational focus.

Risk Taking

Success rate and risk taking. The influence of success rate on risk taking was examined by analyzing the average of the two win/loss combos chosen at the beginning and end of the 'Initial Skill' puzzles, as well as the beginning and end of the 'Calibration' puzzles. Specifically, a 2 x 2 x 2 Success Rate x Stage x Segment mixed ANOVA was conducted. Success rate was the between-subjects variable, and consisted of high or low success rate. Stage and Segment were within-subjects variables. Stage referred to the 'Initial Skill' and 'Calibration' puzzles, and Segment referred to the early (beginning) and late (end) selections. The dependent variable was risk taking, measured by the average of two adjacent win/loss combo selections. Taking the average of two win/loss combos was done in an attempt to get a more reliable measure without averaging over too many trials and thus inadvertently averaging over the effects of learning.

In accordance with experience-based paradigm predictions, it was hypothesized that participants would be sensitive to their success rate, such that those with a high success rate would take more risks than those with a low success rate. It was assumed that at the beginning of the ‘Initial Skill’ puzzles, participants in both conditions would start by choosing intermediate win/loss combos and avoid the extremes, since they had not yet experienced their success rate. By the end of the ‘Initial Skill’ stage and the beginning of the ‘Calibration’ stage, participants had their initial experience of doing well or poorly, so those who had a low success rate were expected to begin to take fewer risks than those with a high success rate. By the last two win/loss combo selections of the ‘Calibration’ puzzles, participants had had plenty of opportunities to learn and experience their success rate. Provided that participants were in fact sensitive to their success rate, significant differences in risk taking by the end were anticipated. Those with a low success rate were then expected to decrease their risk taking even further and choose lower win/loss combos, while those with a high success rate were expected to increase their risk taking even further and choose higher win/loss combos.

As expected, there was a significant main effect of success rate, $F(1,201)=21.60$, $p<.001$, partial $\eta^2=.097$, with those who had a high success rate taking more risks overall (4.74, SE=.14) than those who had a low success rate (3.81, SE=.14). Additionally, there were significant main effects for stage, $F(1,201)=61.94$, $p<001$, partial $\eta^2=.24$, and segment, $F(1,201)=95.41$, $p<.001$, partial $\eta^2=.32$. In both cases, more risks were taken in the later portions of the experiment. More risks were taken overall in the ‘Calibration’ stage (4.74, SE=.12) than in the ‘Initial Skill’ stage (3.81, SE=.11). Also, more risks were taken on average in late selections (4.72, SE=.12) than in early selections (3.83, SE=.10).

Both stage and segment interacted with success rate to influence risk taking. The Success Rate x Stage interaction, $F(1,201)=41.90$, $p<.001$, partial $\eta^2=.17$, is shown in Figure 4. In the ‘Initial Skill’ puzzles, participants in both success rate conditions were fairly conservative and took on roughly the same amount of risk. Differences in risk taking between success rate groups arose in the ‘Calibration’ puzzles, such that those with a high success rate took on more risk than those with a low success rate. The change was primarily due to an increase in risk taking by the high success group; those with a low success rate did not change their risk taking appreciably as they started at a relatively low combo level and stayed there.

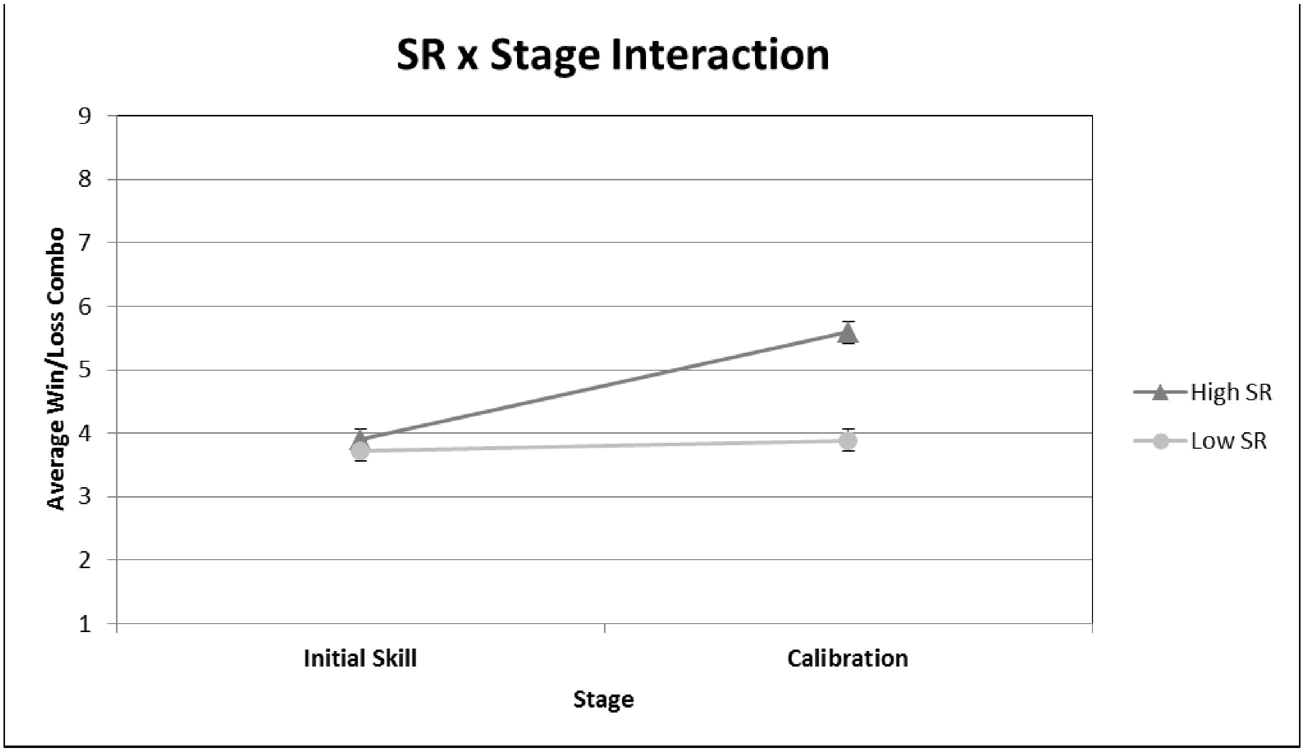


Figure 4. Success Rate (SR) x Stage interaction for risk taking. Risk taking was measured by the average of two adjacent win/loss combo selections (Average Win/Loss Combo). The higher the average win/loss combo, the more risk taken. Results are averaged over segment. Standard error bars are displayed.

As shown in Figure 5, success rate also significantly interacted with segment to influence risk taking, $F(1,201)=33.52$, $p<.001$, partial $\eta^2=.14$. Similar to the Success Rate x Stage interaction, in the early selections of a stage, both groups were conservative in their win/loss combo selections. Differences in risk taking were more pronounced in the late selections of a stage, such that those with a high success rate took on even more risk than those with a low success rate. Again, low success rate participants did not change their risk taking from early to late selections as much as high success rate participants.

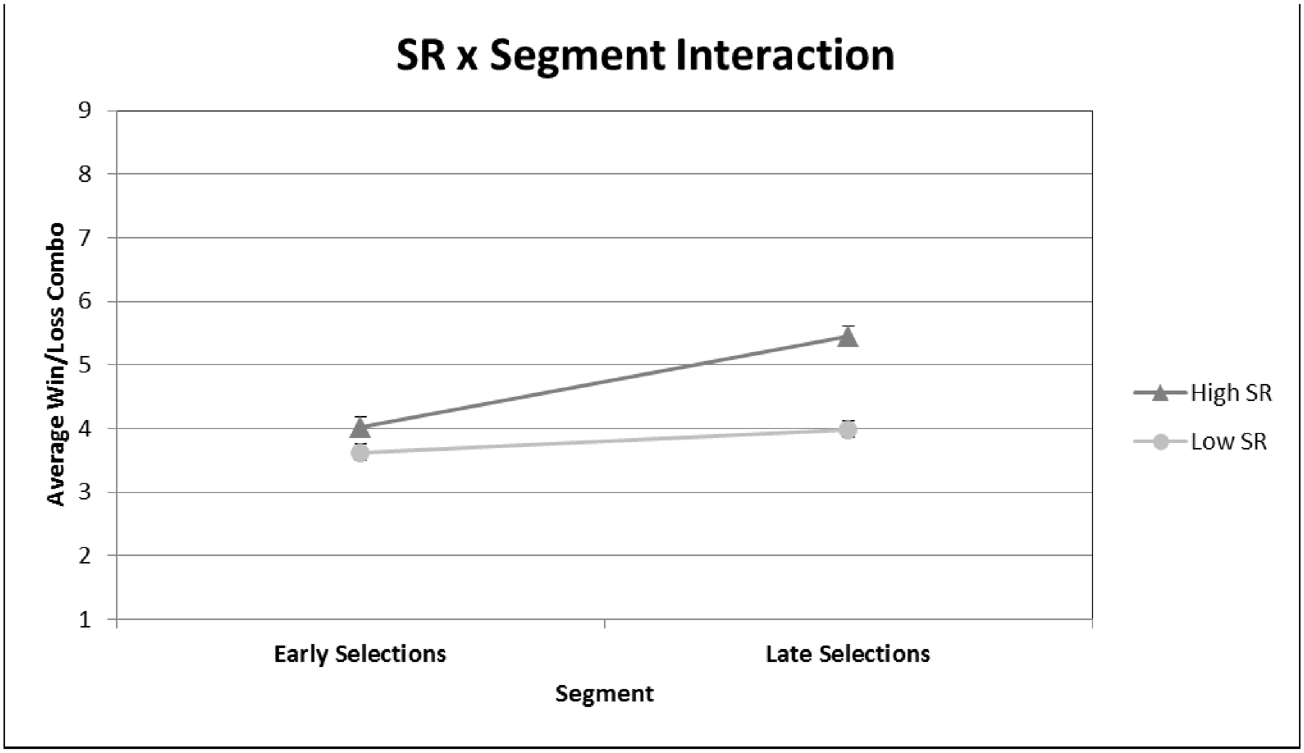


Figure 5. Success Rate (SR) x Segment interaction on risk taking. Early and late selections refer the average of the first and last two win/loss combo selections in a stage, respectively. Risk taking was measured by the average of two adjacent win/loss combo selections (Average Win/Loss Combo). The higher the average win/loss combo, the more risk taken. Results are averaged over stage. Standard error bars are displayed.

Stage significantly interacted with segment, $F(1,201)=35.44$, $p<.001$, partial $\eta^2=.15$, as seen in Figure 6. The bigger differences in risk taking are seen between early and late selections in the 'Initial Skill' stage, such that more risks are taken later in the 'Initial Skill' stage than early. There are little to no differences in risk taking between early and late selections in the 'Calibration' stage. This suggests that participants, regardless of success rate, adjusted their risk taking between early and late selections in the 'Initial Skill' stage, with a shift towards risk seeking. Participants then did not significantly adjust much further within early and late selections of 'Calibration' stage.

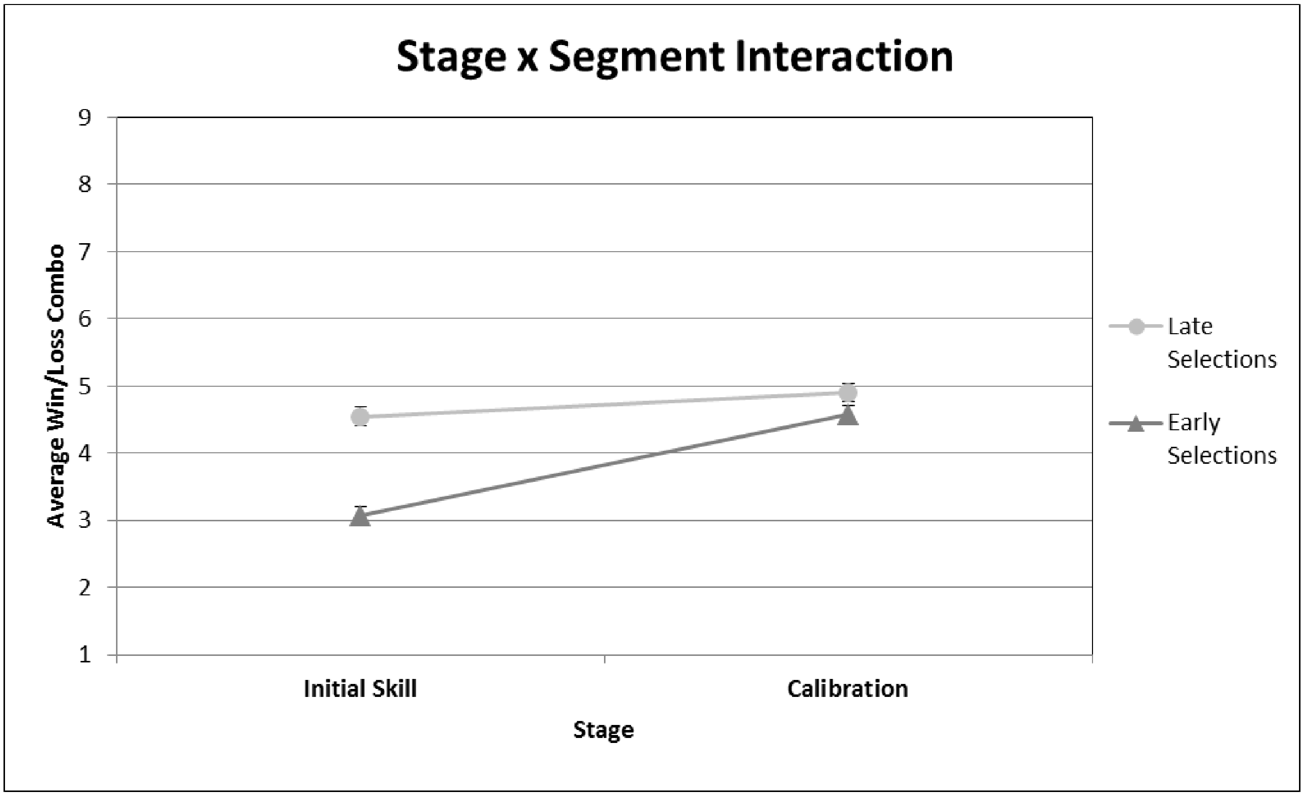


Figure 6. Stage x Segment interaction on risk taking. Early and late selections refer the average of the first and last two win/loss combo selections in a stage, respectively. Risk taking was measured by the average of two adjacent win/loss combo selections (Average Win/Loss Combo). The higher the average win/loss combo, the more risk taken. Results are averaged over success rate. Standard error bars are displayed.

The patterns seen in these two-way interactions are in line with our expectations that participants would be sensitive to their success rate. When making the first two win/loss combo selections, participants had little or no experience with their success rate, and differences between success rate groups in risk taking were minimal or non-existent. More adjustments in risk taking were made within the 'Initial Skill' stage as participants began to experience their success rate, and less were made in the 'Calibration' stage as participants had plenty of opportunities to learn about their success rate by that point. This was especially true for those in the high success rate. It also seems that those in the low success rate may have experimented with more risky combos early on but then gradually returned to safer levels. As the experiment progressed and participants had those opportunities to learn about their success rate, differences in risk taking between conditions became more pronounced.

The patterns are in accordance with general experience-based paradigm predictions. As predicted by experience-based paradigm research, those with a high success rate eventually took more risks compared to those with a low success rate. The Success Rate x Stage x Segment interaction was not significant, $F<1$.

Success rate calibration of risk taking. Sensitivity to success rates was clearly observed in the primary analysis, but we wanted to know how well participants used their experienced success rate information to make the best risky decisions. To measure how well participants used this information, a single-sample t-test was conducted for each success rate group. The t-test compared the average of the last two win/loss combos selected to the optimal win/loss combo for that success rate. Reaching the optimal level would indicate that success rate information was used well, and that participants appropriately calibrated at least on average. This was a more rigorous test of experience-based paradigm predictions of the underweighting of rare events as the underlying rationale for the pattern. If results are consistent, then those with a low success rate should have a lower average win/loss combo compared to their optimal, as they would underestimate the rare event of doing well. Those with a high success rate should have a higher average win/loss combo compared to their optimal, as they would underestimate the rare event of doing poorly.

The average of the last two win/loss combos in the 'Calibration' stage was found to be significantly different than the optimal win/loss combo for both high and low success rate groups bu tin the wrong direction. Those with a low success rate had an average win/loss combo of 3.77 (SD=1.79) which was above their optimal win/loss combo of three, $t(101)=4.37$, $p<.001$, d=.60. Those with a high success rate had an average win/loss combo of 6.02 (SD=2.12) which was below their optimal win/loss combo of seven, $t(100)=4.61$, $p<.001$, d=-.65.

These results suggest that participants were sensitive to their success rate, and eventually gravitated in the appropriate direction towards their optimal win/loss combo, but failed to calibrate completely. Participants ended up closer to the middle when selecting win/loss combos. Unlike our predictions, the pattern of risk taking was not consistent with experience-based paradigm predictions. Those with a low success rate took relatively more risks than optimal, and those with a high success rate had a lower average win/loss combo compared to their optimal.

Secondary analyses of risk taking patterns. First, an analysis was done to determine whether the randomly assigned combo levels in the instructions had any influence on the relationship between success rate and risk taking. Furthermore, the average win/loss combo selection made by those with a high or low success rate was plotted for each trial in order to better understand and visualize how risk taking changed over time.

In an attempt to balance out the ordering effects of anchoring that could arise due to explaining the win/loss combo examples using Combos 1 and 9 during instructions, the order of their use had been randomly counterbalanced to each experimental session. A 2 x 2 Success Rate x Instruction Order between-subjects ANOVA was conducted in order to determine if the instructions had an influence on risk taking. Instruction order referred to the experimenter explaining the practice puzzle with Win/Loss Combo 1 then 9 or Win/Loss Combo 9 then 1. The dependent variable was the average of the first 2 win/loss combo selections made in the 'Initial Skill' puzzles. This was the chosen dependent variable because any effects of instructions would most likely be of influence closer to when instructions were given, i.e., in the early win/loss combo selections. No influence of instructions was found. The main effect of instructions was not significant, $F<1$, indicating that risk taking did not differ as a function of instruction order. Additionally, the Success Rate x Instruction Order interaction was not significant, $F<1$, suggesting that the relationship between success rate and risk taking was not influenced by the instructions.

Figure 7 depicts the win/loss combos selected over time by each success rate group. Participants were able to discern quickly how well or poorly they were doing, as there were already differences between the groups in average win/loss combos chosen between the beginning and end of the 'Initial Skill' stage (trial 5). Those with a high success rate started to increase their risk taking, as predicted. Those with a low success rate also significantly started to increase their risk taking between the beginning and end of the 'Initial Skill' stage, $t(101)=-5.21$, $p<.001$, $d=-.52$, which was not expected. Instead of responding to their success rate by immediately taking fewer risks in the 'Initial Skill' stage, low success rate participants opted to choose higher win/loss combos, potentially because they were still exploring or thought they could improve their skill. However, by the end of the 'Initial Skill' stage, low success rate participants took fewer risks relative to high success rate participants, $t(201)=2.42$, $p<.05$, $d=.34$. These relative differences became more pronounced after receiving the message about purported skill level between the 'Initial Skill' and 'Calibration' stages (between trial 5 and 6).

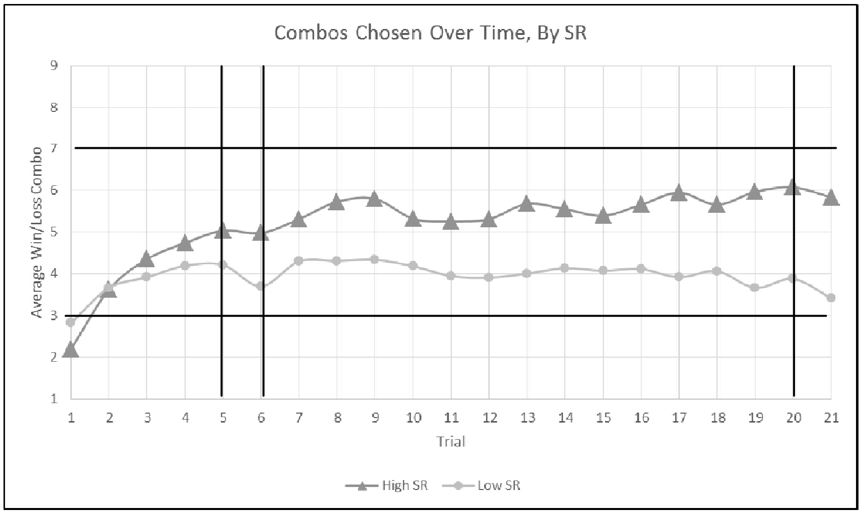


Figure 7. Risks taken over time by success rate group. Each point corresponds to the average win/loss combo selection by success rate group for each trial (once every two puzzles). The higher the average win/loss combo, the more risk taken. Vertical lines show separation between stages. Trials 1 through 5 are in the Initial Skill stage. The skill message was delivered between Trial 5 and 6. Trials 6 through 20 are in the Calibration stage. Trial 21 refers to the win/loss combo chosen for the Prize Round puzzle. Horizontal lines refer to the optimal win/loss combos. Seven is the optimal for the high success rate group, three for the low success rate group.

As seen in Figure 7, as time passed and more puzzles were played, those with a high success rate gradually took more risks. However, by the last trial in the 'Calibration' stage (trial 20), 54% of participants were still relatively risk averse on average compared to their optimal win/loss combo of seven. Nevertheless, another 33% were relatively risk seeking on average compared to their optimal win/loss combo, and 13% took on their optimal amount of risk. Thus, there was considerable variability in risk taking even at the end of 20 trials.

Those with a low success rate started at a low combo and gradually increased their risk taking in the initial stage, but then gradually drifted toward taking fewer risks. By Trial 20, 57% of the participants were still relatively risk seeking on average compared to their optimal win/loss combo of three. Another 28% were relatively risk averse on average, and 15% took on their optimal amount of risk. Again, there were noticeable individual differences in the selection of final risk levels, though as a group risk taking had drifted in a more conservative direction relative to those with the high success rate.

Exploratory Analyses Regarding Satisfaction, Attributions and Motivational Focus

Satisfaction with decision strategy and overall performance, and attributions regarding the role of skill and chance were examined along with motivational focus. These were measured using five four-item scales, and were included as exploratory dependent variables of interest. Scores were reverse-coded when necessary to ensure that a higher score indicated a move towards the positive end of the scale. Final score ranges can be seen in Table 3. The score range remained -3 to 3 for all scales except skill. Skill was re-coded to a range of 0 to 3 in order to better represent the opposite ends of the scale—beliefs that no skill was involved to beliefs that skill was especially involved.

Before combining the items, they were tested for reliability. Table 3 lists the items used in subsequent analyses and the final reliability. The skill and decision strategy satisfaction scales maintained each of their four original items. The performance satisfaction and chance/luck scales each had one of their original items removed to achieve optimal reliability. Reliability on these four adjusted scales were all in excess of .75 and were deemed acceptable. The success/failure focus scale, however, did not achieve acceptable reliability, α=.57.

In an attempt to take a cursory look at motivational focus since the success/failure scale did not achieve acceptable reliability, an independent samples t-test was conducted to see if there were any differences between success rates in average scores on one item from the scale. The item used was "I was focused on avoiding negative outcomes/achieving positive outcomes." It was used because it was most closely aligned to motivational focus. No significant differences on this item were found between the two success rate conditions, $t(201)=-1.15$, $p=.25$. High and low success rate participants had an average score of .52 and .85, respectively, indicating that participants in both success rate groups had a slight tendency to focus more on achieving positive outcomes. Thus, we have no evidence for our hypothesis that motivational focus would differ based on success rate. Due to the lack of reliability of the subscale and no differences found in a crucial item, motivational focus was not included in the remaining analyses.

Table 3. Final Scale Items Used in Analyses with α and Score Ranges

Construct	Negative End of Scale	Positive End of Scale	α	Score Range
Skill	My current total was not due to my skill.	My current total was due to my skill.	0.79	0 to 3
Skill	My skill had no influence over my performance.	My skill had substantial influence over my performance.		
Skill	My skill is not responsible for how much I won or lost.	My skill is responsible for how much I won or lost.		
Skill	My skill had nothing to do with my scores.	My skill had everything to do with my scores.		
Chance/Luck	I was unlucky in my puzzle outcomes.	I was lucky in my puzzle outcomes.	0.75	-3 to 3
Chance/Luck	Overall I was unlucky.	Overall I was lucky.		
Chance/Luck	I feel that my scores were due to bad luck.	I feel my scores were due to good luck.		
Performance Satisfaction	I feel like I did not do well.	I feel like I did well.	0.79	-3 to 3
Performance Satisfaction	I expected to do better.	I expected to do worse.		
Performance Satisfaction	I am not satisfied with my score.	I am satisfied with my score.		
Decision Strategy Satisfaction	I am disappointed in my decision strategy.	I am proud of my decision strategy.	0.83	-3 to 3
Decision Strategy Satisfaction	I am not happy with my decision strategy.	I am happy with my decision strategy.		
Decision Strategy Satisfaction	My decision strategy was not effective.	My decision strategy was effective.		
Decision Strategy Satisfaction	I feel bad about my decision strategy.	I feel good about my decision strategy.		

Note. Skill was re-coded as 0 to 3 to better represent the items at the end of the scale. Chance/luck and performance satisfaction scales each had an item removed to achieve optimal reliability. The success/failure focus scale is not present in this table because acceptable reliability was not achieved.

Satisfaction with performance and decision strategy. Ratings of satisfaction with performance and decision strategy were used as a manipulation check. Those with a high success rate should be more satisfied with their performance and decision strategy than those with a low success rate, because they were generally doing well in the task. T-tests were conducted for both of these scales in order to see whether there were the expected differences in ratings between success rate groups.

Figure 8 shows the satisfaction results. In line with our predictions, those with a high success rate were more satisfied with their performance, $t(201)=13.94$, $p<.001$, and their decision strategy, $t(201)=10.81$, $p<.001$, than those with a low success rate. Low success rate was associated with negative ratings of performance as expected. However, those with a high success rate were not particularly satisfied in general, suggesting that something other than doing well was affecting satisfaction, or that their aspirations for success were higher than the 67% they were achieving. Thus, our manipulation check was effective in a relative sense but only weakly effective in an absolute sense.

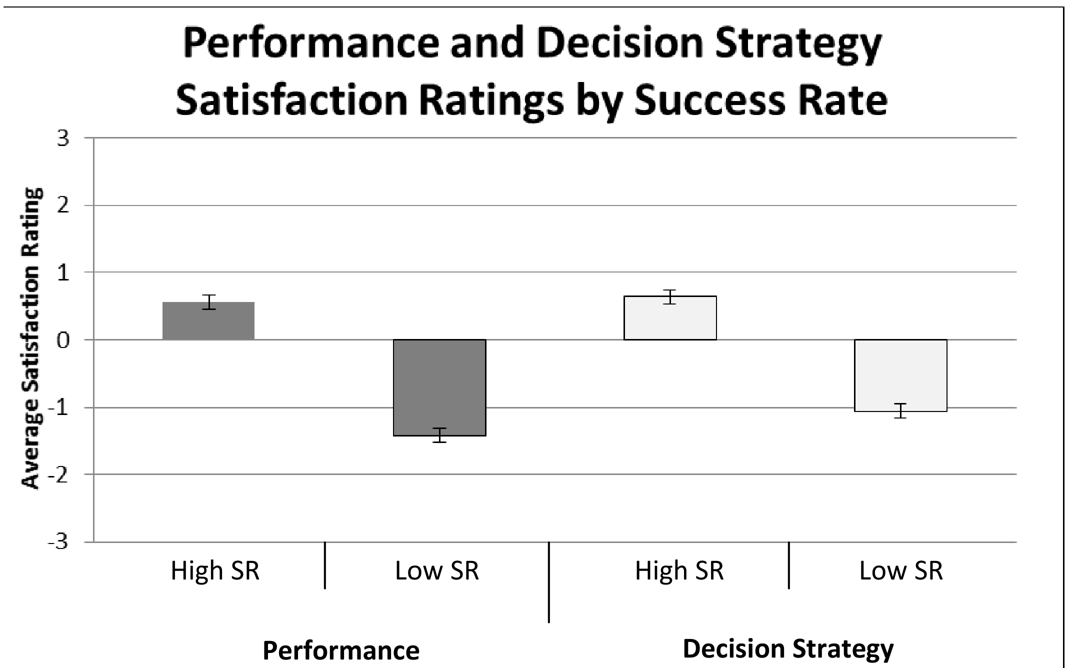


Figure 8. Ratings of satisfaction with performance and decision strategy for each success rate (SR). The average satisfaction rating was the average of the scores on the corresponding final scale items. Ratings were from -3 (very dissatisfied) to 3 (very satisfied). Standard error bars are displayed.

The role of skill and chance. Before any analyses were conducted regarding the role of skill and chance, chance/luck scores were re-coded from a scale of -3 (bad luck) to +3 (good luck) to a scale of 0 to 3 so they could attempt to be compared to skill scores. Zero referred to beliefs that chance did not play a role in performance, and three referred to beliefs that chance had a lot to do with performance (irrespective of whether the influence was good or bad). This was similar for the skill scale, in which zero referred to beliefs that skill did not play a role in performance, and three referred to beliefs that skill played a significant role in performance. Due to the re-coding of skill and chance/luck, it is possible that the scores are not entirely comparable, as one full step in skill is actually a half step after the re-coding. For the purpose of exploratory analyses, comparability was tentatively assumed.

One set of exploratory analyses consisted of a t-test comparing each success rate group in order to examine overall differences in attributions of skill and chance. Results were somewhat in accordance with our predictions, and can be seen in Figure 9. Skill was believed to play more of a role in performance than chance in the high success rate group only, $t(100)=7.46$, $p<.001$, as their skill ratings were significantly higher than chance ratings. The differences between skill and chance ratings in the low success rate group were not significant, $t(101)=.95$, n.s., suggesting that participants did not believe skill or chance to play more of a role than the other in performance.

In a test of the self-serving bias, we compared attributions regarding skill and chance across success rates. Those in the high success rate condition rated skill as having more to do with their performance than those with a low success rate, $t(201)=3.79$, $p<.001$. Conversely, those with a high success rate rated chance as having less to do with their performance than those with a low success rate, $t(201)=-2.19$, $p<.05$. This is consistent with pervasive findings of self-serving bias in the literature (Campbell & Sedikides, 1999). While we found results that went along with our predictions in general, it seems a bit surprising that average scores on both scales were small to moderate. Thus, participants in neither condition seemed to think skill or chance played an especially large role in performance.

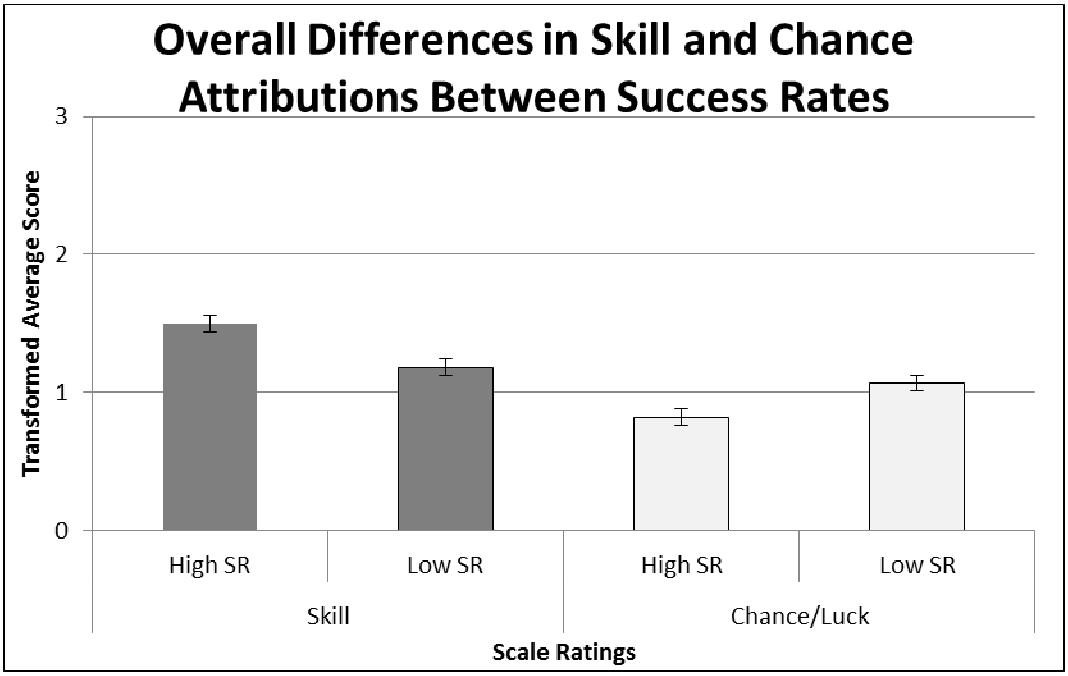


Figure 9. Overall differences in attributions of skill and chance between success rate (SR) groups. The transformed average score refers to the average of the scores on the corresponding final scale items. The average scores were than transformed so that all ratings went from 0 (played no role) to 3 (played a significant role). Standard error bars are displayed.

To explore whether attributions of skill and chance were specifically related to risk taking, the relationship between skill ratings and risk taking, as well as chance/luck ratings and risk taking, were studied within each success rate. This allowed for a test of how well our results matched our hot hand related predictions. If our results fit, then for those with a high success rate, higher skill ratings should be associated with more risks being taken given an expectation of continued successes. For those with a low success rate, higher skill ratings should be associated with less risks being taken given an expectation of continued failures. Correlations were computed to look at these possible relationships. The risk taking dependent variable consisted of the average of the last 2 win/loss combo selections in the Calibration Stage.

No significant associations were found between attributions of skill/chance and risk taking, in either condition. The skill rating and risk taking correlation was not significant in either the high success rate, $r(99)=.05$, n.s., or the low success rate, $r(100)=-.03$, n.s., groups. There was also no significant association between chance/luck ratings and risk taking for the high success rate, $r(99)=-.06$, n.s., and the low success rate, $r(100)=-.02$, n.s., groups. Since we had sufficient power to detect a relationship and there were no issues of variability in attribution scores or risk taking, these results go against hot hand related predictions.

Summary

To summarize, participants were sensitive to their success rate. Their risk preferences patterns looked similar to experience-based paradigm predictions overall, such that those with a high success rate took more risks than those with a low success rate. However, when calibration was tested, high success rate participants ended the experiment by choosing win/loss combos less risky than their optimal, while low success rate participants ended by choosing combos more risky than their optimal. In addition, low success rate participants had a slight tendency to increase their risk taking early on, and only with additional experience to drop back down to a lower level of risk.

Overall attributions of skill and chance were in accordance with predictions of a self-serving bias. Those with a high success rate believed skill to be more at play than chance, whereas skill and chance were seen as having a similar role by low success rate participants. When the association between the attributions and risk taking was analyzed, however, hot hand related predictions were not confirmed, and beliefs about skill and chance did not seem to be related to risk taking behavior.

Discussion

This study examined how risk preferences are influenced by one's experienced success rate in an uncertain environment, using a task that captured characteristics of many real world environments. The results suggest that people are sensitive to their success rate, in that participants changed their risk taking behavior after only a few trials. High success rate participants responded in the expected direction and started taking more risks after a few trials. Low success rate participants initially started taking more risks despite their low success rate, but still chose safer win/loss combos compared to high success rate participants. As the trials progressed, those who had a high success rate began taking on more risk and those with a low success rate gradually began taking fewer risks.

Comparisons to Experience-Based Paradigms

We had expected that the above risk preference pattern would be similar to the typical pattern found when using experience-based paradigms. This was because experience-based paradigms, similar to our experiment, rely on the participant experiencing probability through a series of events rather than through a numeric description as in description-based paradigms. The usual risk preference pattern predicted by experience-based paradigms is risk seeking in the positive domain, or with a high success rate, and risk aversion in the negative domain, or with a low success rate. Results supported experience-based paradigm predictions. Those with a high success rate took more risks relative to those with a low success rate, even when a shift towards risk seeking was found for both success rate groups in the 'Initial Skill' stage.

In the 'Initial Skill' stage, the shift towards risk seeking was expected for those with a high success rate only. Those with a low success rate may have initially started to take risks in this stage because they expected their skill to get better as they played more puzzles. Skill is often thought of as working in one direction; developing skill through effort would typically be expected to improve performance, not hurt it (e.g., Schneider, 2001). However, by the end of the initial stage, low success rate participants took fewer risks than those with a high success rate, and this pattern gradually continued in the 'Calibration' stage, as expected from experience-based paradigm predictions. This might have been because after more experiences of doing poorly, low success rate participants realized they were not improving and adjusted their risk taking behavior accordingly.

To more rigorously test whether our results were in line with experience-based paradigm predictions about underweighting of rare events, we examined how well people calibrated their performance to their success rate. Those who had a high success rate were expected to take on more risk relative to their optimal level by the end because they would underestimate the rare event of doing poorly. Alternatively, those with a low success rate were expected to take on less risk relative to their optimal level by the end, as they would underestimate the rare event of doing well. Our results demonstrate that participants moved in the direction towards their optimal level of risk, but were just shy of reaching it. Those with a high success rate took on less risk relative to their optimal, and those with a low success rate took on more risk relative to their optimal. These tendencies were not consistent with experience-based paradigm predictions overall.

Their tendencies could be seen as more in line with description-based paradigm predictions, suggesting the possible overweighting of rare events. We did not expect calibration results to be similar to description-based paradigm predictions because probabilities were not made explicit in the puzzle task. Thus, the reason for the overweighting of rare events, if that is what is happening, is unclear. Both paradigms rely on an explanation focused on the process of underweighting or overweighting of rare events. Given the partial compatibility of our results with both paradigms, a conflict arises suggesting that processes other than (and possibly in addition to) the weighting of rare events may influence risk taking tendencies in uncertain environments.

One possibility is that the calibration results might be due to an affinity for the status quo. The status quo effect (e.g., Samuelson & Zeckhauser, 1988) refers to the decision to do nothing and maintain a current or previous position. It is a bias when people more often choose to stick with the status quo alternative than another alternative. In terms of the puzzle task, the status quo would be similar to choosing the same win/loss combo throughout the experiment in order to maintain the current position. The status quo bias could explain why participants as a group eventually stuck with choosing more intermediate win/loss combos, leading to a middling effect by the end of the experiment. Once participants experienced their success rate in the initial trials and changed their risk taking accordingly, the cost of choosing another alternative (i.e., a different win/loss combo) besides what they had already been choosing might not have seemed worth it. It might not have been worth it to participants because they were aware that the experiment involved an element of uncertainty, and the perceived potential cost of trying out a different win/loss combo might have outweighed any potential benefit to their performance.

Another possibility is that the calibration results might be due to an anchoring and adjustment strategy used by participants. Anchoring and adjustment is one of three classic heuristics proposed by Tversky & Kahneman (1974) in which an initial reference point (i.e., anchor) is adopted, insufficient adjustments are made, and the resulting judgment is often biased towards the anchor (e.g., Tversky & Kahneman, 1974; Furnham & Boo, 2011). In terms of calibration, this would mean that participants could have anchored onto their initial win/loss combo selection. Initial selections were fairly conservative suggesting a typical anchor that avoided extremes and was slightly risk averse relative to the middle of the scale. Although participants as a group made adjustments in the appropriate direction, they might have made insufficient adjustments and stayed closer to intermediate win/loss combos, thus leading to a middling effect by the end of the experiment. It is interesting to note that since there were no significant effects of instruction order on risk taking, participants most likely were not adopting either of the (extreme) win/loss combo examples from the instructions as their starting anchors, and instead tended to use an intermediate but relatively cautious starting point.

The status quo bias and an anchoring and adjustment strategy both suggest that, after participants as a group initially changed their risk taking in the appropriate direction, their subsequent adjustments in risk taking were small. This led them to just miss reaching their optimal level of risk (as a group). According to the status quo bias, small adjustments were made because participants as a group preferred maintaining their current level of risk instead of choosing different win/loss combos. An anchoring and adjustment strategy suggests that small adjustments were made because participants anchored on to their initial intermediate win/loss combo selections. Both suggest a tendency to adjust conservatively relative to some default. This tendency might be especially common in situations of uncertainty.

The tendency to adjust conservatively may also be because participants did not feel that skill did not play a large role in performance overall. Since skill was not seen as having an overwhelming part in determining performance, participants may have not felt the need to go to the extremes. High success rate participants may not have thought that skill was playing a major role but they could recognize that they were doing well, so they increased the risks taken to a certain point but ended up below the optimal. Low success rate participants may also not have thought that skill was a crucial factor but they could recognize that they were doing poorly, so they decreased their risks taken to a certain point and ended up above the optimal. It is also possible that more time spent playing the puzzles and a stronger skill manipulation was necessary in order for participants to reach their optimal level.

Evidence for experience-based paradigms is mixed. We found similar risk preference patterns overall, but calibration results suggest that something else might be driving how participants ability to approach an optimal level of risk besides or in addition to the weighting of rare events. The tendency to adjust conservatively, based on a conservative win/loss combo anchor or a preference for maintaining the current position, may have led to the middling effect by the end of the experiment. Furthermore, introducing the element of skill may have changed how participants approached decisions involving risk in ways not predicted by experience-based paradigms.

Potential for Individual Differences

Generally, it seems that participants started off with a conservative but intermediate anchor, made adjustments as they experienced their success rate, and gradually leveled off in terms of the amount of risk they were willing to take on. While it is important to understand this group behavior, there were also noticeable individual differences. Variations were possible in the starting anchor, and how often and when each participant fluctuated in their risk taking from trial to trial. For instance, individuals differed in how well they calibrated their success to their environment. Some individuals were better or worse at calibrating than others. Out of those who had a high success rate, just over half took fewer risks in the end compared to their optimal level of risk. The remaining participants either took on more risk in the end compared to their optimal, or took on the optimal amount of risk. Out of those who had a low success rate, more than half took on more risk in the end compared to their optimal. The remaining participants either took on fewer risks in the end compared to their optimal, or took on the optimal amount of risk. Exploring individual differences further will help to illuminate why people within success rate groups differed in their risk taking, as well as why some people were more or less calibrated.

This thesis attempted to explore how motivational focus differed as a function of success rate and not in terms of individual differences. Exploratory evidence for motivational focus differences between groups was not found in the puzzle task. The success/failure focus scale was unreliable, suggesting that simply transforming items from a previous promotion/prevention scale was not enough to show whether participants as a group were motivated towards the positive or away from the negative. The critical item used to explore if there were any differences in motivational focus between success rate groups also did not support the idea that those with a high success rate would approach the positive and those with a low success rate would avoid the negative. It is possible then that the experience of success rate was not enough to push people towards focusing on the positive or avoiding the negative, but that we may have found significant individual differences in motivational focus if we had measured them. A person’s tendency to approach the positive or avoid the negative might influence how they used their successes and failures to inform them of how much risk to take on. An example of a relevant theory is SP/A theory (e.g., Lopes, 1983), which suggests that there is a dispositional factor of being more security or potential focused, and this might lead one person to take a risk and another to play it safe, even if they had the same success rate.

Another individual difference to be explored in future research is beliefs about luck. In a situation that involves an element of chance, how that chance element is believed to work either for or against someone might drive risk taking. Darke and Freedman (1997) constructed the Belief in Good Luck (BIGL) scale, which assesses individual differences with respect to beliefs about luck. People can maintain the view that luck is fairly stable and influences outcomes in their favor. For example, if people are more disposed to view chance as working in their favor, then they might expect their likelihood of succeeding to increase as a result of this, and would be more risk seeking than people who did not have this inclination. Others may believe that luck is less stable and more random, and would then have different risk preference patterns. This thesis addressed beliefs about chance and luck, but only specific to the task environment. Studying how beliefs about luck differ as a function of individuals remains to be explored. A variety of other individual differences, including both cognitive and motivational factors, might be worth exploring.

The Role of Beliefs about Skill and Chance

This thesis expanded upon the experience-based paradigm by including elements of both skill and chance. The puzzle task did not include real skill, but the illusion of skill. This was of greater interest because in real world situations, we often do not know how much skill we have or how much of an influence it has on outcomes. People then must rely on success rate information to help them figure out how much skill they have and how much of a role it plays in outcomes. Therefore, we were interested in beliefs about skill and chance.

Results suggest that participants may have a relatively sophisticated understanding of events in that they infer that both skill and chance are factors in their performance. In both the high and low success rate conditions, participants acknowledged that both were likely to play a role in their outcomes. It seems likely that people are aware of the trade-off between skill and chance, even though they cannot directly differentiate the two based on experience.

Whether or not results were consistent with the expectation regarding the continuation of streaks in the hot hand (e.g., Laplace, 1951) or gambler's fallacy (e.g., Gilovich, Vallone, Tversky, 1985) research is a more complicated issue. When looking at the association between skill and risk taking for each success rate, there were no significant relationships. Higher skill ratings were not associated with taking more risks for high success rate participants, or fewer risks for low success rate participants.

This conflicts with the literature, which suggests that how success rate is interpreted is related to beliefs about the role of skill and chance (e.g., Ayton & Fisher, 2004; Burns & Corpus, 2004), and that streaks are expected to continue when skill is involved. When skill is involved, streaks of doing well were expected to be related to taking more risks and streaks of doing poorly were expected to be related to taking fewer risks. However, it is possible that participants did not feel like they had enough skill to depend on it when deciding whether or not to take risks. In essence, participants might not have felt that their hand was "hot" enough. Focusing on how much one believes skill to be at play, or how much success is needed to feel confident that successes will continue, may be as important as whether or not one believes skill to be a factor at all.

There was no evidence for a relationship between skill ratings and risk taking within each success rate group. A more precise test of hot hand predictions would include an evaluation of the relationship between risk taking behavior and actually experienced streaks of a particular outcome, within each success rate group.

Conclusions and Future Directions

Real world situations often appear to involve both skill and chance. In these situations, we often do not know exactly how much skill we have, or how big or small a role it plays in determining outcomes. Success rate information can then become very useful in gauging the role of skill and chance in determining outcomes. When in an environment that appears to involve skill and chance, people seem to be sensitive to and use their success rate when making risky decisions. Doing well and having a high success rate leads to taking more risks in the puzzle task. Doing poorly and having a low success rate leads to taking fewer risks in the puzzle task, once an expectation that performance will improve as time passes is disconfirmed. Future studies are needed to better understand what happens when uncertain situations have an element of skill involved.

This thesis addressed how using a success rate in lieu of exact probability information influenced risk taking, as well as the role of skill and chance in interpreting success rate information. This thesis did not address what happens when success rate changes, or when evidence for skill and chance changes. Real world environments not only typically lack exact information regarding probabilities and the amount of skill and chance involved, but this information typically does not always remain constant. There can be more or less uncertainty in the environment, and one can attempt to improve their skill or may face situations that reduce their skill. These factors can change one at a time, or in tandem. If we know that people seem to be sensitive to and use their success rate when making decisions in a situation where they are experiencing a constant success rate, they may react differently when their experience changes in these various ways. Answering this question is a likely next step for better understanding how people respond to risk in real world environments that involve elements of both skill and chance.

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