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How luck and fortune shape risk-taking behaviors

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by

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Abstract

The current study uses a lottery-based paradigm to examine how risk taking is affected by two specific types of good and bad experiences, luck and fortune. Though the terms are often used interchangeably, we suggest that they refer to two separate aspects of risk. Fortune refers to the overall positivity or negativity of the overall context, whereas luck refers to the probability of a better or worse outcome. To make the lottery context fortunate or unfortunate, a set of mixed-valence control lotteries were surrounded by all gain (good fortune) or all loss lotteries (bad fortune). To make the lotteries lucky or unlucky, the proportion of better outcomes received was fixed to be well above (good luck) or well below (bad luck) 50%. Results of the study suggest that, fortune, but not luck, had a significant influence on risk taking behaviors. Participants who experienced good fortune decreased risk taking, and those who experienced bad fortune increased risk taking. When asked, however, participants were unable to differentiate between the luck and fortune manipulations. Gains and losses due to fortune were undifferentiated from gains and losses due to luck. Yet, it was found that the number of gain outcomes received, which was determined by the luck-fortune combination, largely determined subjective experiences of luck and fortune. Consistent with the somatic marker and hedonic editing hypotheses, more gain outcomes led to a heightened sense of good luck and good fortune. Following on SPA (security/ potential aspiration) theory, we suggest that these differences in risk taking behavior in response to fortune may be due to increased attention to goals emphasizing security versus potential.

How Luck and Fortune Shape Risk-Taking Behaviors

"It's better to be lucky than smart, but it's easier to be smart twice than lucky twice."
-Unknown Author

There is a fine line between luck and fortune. In the English language we sometimes use these terms interchangeably. For this reason luck and fortune seem inextricably connected, but upon closer inspection, there may be a subtle yet important distinction between the two concepts. Whereas luck is more closely related to particular events involving chance and probability, fortune is generally associated with a relatively stable condition. For example, a person is viewed as lucky when she wins the lottery, while a person is seen as fortunate when he is in good health. Each example describes a positive experience, but they are different types of positive experiences. The former is unpredictable, uncontrollable, and relatively unlikely. The latter is more established, and is not necessarily unlikely. Labeling an event as fortunate or lucky may not just be an issue of terminology, but may be indicative of distinct contexts that may bring unique influences to decision making. How we make decisions in situations involving luck and fortune may therefore differ. As we consider this possibility throughout the rest of this paper, the term 'luck' will refer to both good and bad luck, and the term 'fortune' will refer to both good and bad fortune.

Luck and Fortune as Separate Constructs

From ancient Rome to the present day, luck and fortune have been topics of interest. The ancient Roman goddess *Fortuna* was said to control luck and chance, and praying to her could

bring one good luck. Nearly 2,000 years later, we may not be closer to controlling or predicting luck, but we may be getting better at characterizing what luck is, and how it differs from fortune.

Psychologists Darke and Freedman (1997a) touched upon luck and fortune being distinct constructs in a paper aimed at validating their Belief in Good Luck Scale (BIGL). The goal of the scale was to differentiate between two contrasting beliefs about where luck comes from: (1) the belief that luck is an internal trait that, if possessed, can influence future events in one's favor, and (2) the belief that luck is an external force that randomly and unreliably determines future events. In the process of validating this scale, tests of divergent validity were included to distinguish luck from conceptually similar constructs, such as internal locus of control and optimism, as well as beliefs about fortune. When tested, beliefs about luck were not found to be related to beliefs about fortune, suggesting that the two constructs were distinct. Items used to assess fortune included more stable conditions that have been established by past events such as health, economic situations, and personal talents. The authors then concluded that although luck and fortune are sometimes used synonymously, there are some situations that are more often referred to as fortunate than lucky.

Although the primary goal of Darke and Freedman's study was not to differentiate fortune from luck, it did bring attention to the idea that luck and fortune may be two different constructs. In the field of psychology, relatively little research beyond the work of Darke and Freedman can be found distinguishing these constructs. Within philosophy, however, there exists a sizable body of literature aimed at more precisely defining these constructs. Although the literature is focused more on defining luck than fortune, and is more abstract than what we would typically see in psychology, it is a useful starting point for psychologists in identifying key elements that can be used to distinguish luck from fortune.

Luck

In reviewing the works of philosophers such as Rescher (2001), Barrett (2006) and Coffman (2007), three defining features of luck emerge: (1) the event needs to be significant to the subject, (2) outcomes must be unlikely and unpredictable, and (3) outcomes must be out of the direct control of the subject. Coffman notes that if any one of these requirements is not satisfied, the event(s) or outcome(s) of the event(s) cannot be considered lucky.

The first proposed requirement for luck is relatively simple. If the event is not relevant to the subject, it cannot be lucky. Every day, we encounter unlikely situations beyond our direct control, but we do not always label these events as being lucky. Take, for example, a bolt of lightning striking in the middle of an empty field. The probability that a bolt of lightning would hit that exact spot is extremely low, and is out of anyone's control, but we do not consider this event to involve luck. However, if that same lightning bolt hit the tree right next to one's house, and that tree caught on fire, then this event would be labeled as very unlucky because now the lightning strike is personally significant.

The second requirement for luck is that the outcome of the event must be unlikely to occur, and difficult to predict. Consider a raffle in which there is a 1 in 100 chance of winning versus a raffle in which there is a 99 in 100 chance of winning. Which raffle would someone feel luckier winning? Winning the 1 in 100 raffle feels much luckier because it was less likely to success, and the success was far less predictable. If we change the raffle to having a 99 in 100 chance of winning, the losing outcome becomes unlikely and winning likely. Losing this raffle would therefore be a stroke of bad luck, however winning this raffle would not necessarily seem lucky. Coffman would instead say that winning the 99 in 100 is fortunate because although the outcome was positive it was very likely to happen.

To illustrate this difference, Coffman remarks, "While a lottery winner enjoys a stroke of good luck, a lottery loser doesn't suffer a stroke of bad luck, though her lottery loss is mildly unfortunate" (pg. 392). In this example, the player knows that winning is unlikely, so when the outcome is a success the player feels that she has defied probability, and was in fact lucky. On the other hand, not winning, which is the typical state of affairs in most lotteries, does not feel unlucky and is better characterized as being mildly unfortunate.

The final requirement for an event to be marked as lucky, as laid out by the aforementioned philosophers, is that the outcome must be out of the subject's direct control. Superstitions are an excellent example of how humans have tried to exercise control over purely chance events. Knocking on wood to ward off bad luck, and carrying a rabbit's foot to invite good luck are two such ways humans have tried to directly control luck (Fluke, Webster, & Saucier, 2012). However, if it were indeed possible to directly control a lucky event, the event would no longer be lucky. Imagine a roulette player has rigged a wheel so that it always lands on red. The player then proceeds to always bet on red, and therefore always wins. Not only is this player a cheater, but no one would say that he is lucky. If this were an honest player, and the wheel were not rigged, and the same outcome occurred, then the events this player experienced would be considered extremely lucky.

Fortune

Events marked as fortunate or unfortunate are less clearly defined, and typically have been characterized in terms of their relatedness to luck. Some scholars propose that fortune is used to describe past events (Darke & Freedman, 1997a) or that fortune is what luck becomes over time (Barrett, 2006). Others have described the distinction between luck and fortune as a difference in likelihoods, not time (Coffman, 2007). Lucky events have unlikely outcomes,

whereas fortunate events have likely outcomes. However, the characterization of fortune that best encompasses the abovementioned characteristics comes from Pritchard and Smith (2004), who describe fortune as the general positivity or negativity of a relatively enduring state of being.

Operationalizing Luck and Fortune

By adopting Pritchard and Smith's description of fortune, it seems that good fortune or bad fortune is most easily marked by positive and negative shifts in context, such that a string of events are good or bad overall. Luck meanwhile seems to be more closely related to probability, allowing outcomes to be better or worse than expected. In accordance with these descriptions, the current study used a series of two-outcome lottery pairs to manipulate experiences of luck and fortune. Fortune was operationalized within the gambling task by changing the overall context of the gambling experience to be positive or negative. To do this, pairs of lotteries with either all gain or all loss outcomes were presented in a mixed order alongside a set of control lotteries. This created a risky choice situation that was both relatively stable and absolutely good or bad in that the participant's overall gambling experience was positive or negative.

Luck was operationalized within the gambling task by increasing the rate at which a better or worse outcome occurred from what would normally be expected. Unexpectedly receiving the better outcome more often than the probabilistic expectation represented good luck, and receiving the worse outcome more often represented bad luck.

Predictions about the differential roles of luck and fortune could only be derived indirectly based on existing research. Studies specifically looking at luck and risk are sparse (c.f., Darke & Freedman, 1997b; Wohl & Enzle, 2003), and research on fortune and risk is nearly non-

existent. However, there are a number of studies that have used monetary lotteries, similar to those used in this study, to test risk taking in a variety of positive and negative contexts. Although the authors may not refer to these manipulations as "luck" or "fortune," some of the manipulations are conceptually related and helped inform predictions as to how luck and fortune would affect risk-taking behavior.

Gains, Losses, and Risk-Taking Behavior

In a classic study, Thaler and Johnson (1990) investigated the effects of recent gains and losses on risk taking in a gambling task. A gain or loss experienced in this context could potentially be perceived as either the result of luck or fortune. When participants were told that they had won $30, they became more risk seeking than when an equivalent lottery was presented without the $30 windfall. This tendency to become more risk seeking after experiencing a gain was termed the *house money effect.* Similarly, participants' risk taking decreased if they were told they had lost $30 when compared to choices for an equivalent lottery with no starting loss, with one exception. If after a loss the following lottery presented the opportunity to recoup the just-experienced loss, participants were more likely to take the risk. This exception was termed the *break even effect.*

The $30 endowment before the lottery selection could be seen as a one-time lucky event or it might be seen as setting the general context of the gambling situation to be positive. Regardless of whether this is luck or fortune, the presence and valence of the initial endowment had a sizable effect on willingness to take risks. Good precursors enhanced risk taking and bad ones generally reduced risk taking, except in special cases. Thaler and Johnson (1990), however, did not explore how these good and bad precursors may differ from one another in terms of variables such as luck and fortune.

Huber (1994, 1996) perhaps has come closest to discriminating different types of good and bad events that might correspond to luck and fortune. Using a multi-stage investment paradigm, Huber investigated the effects of three types of gain/loss situations. Two of these manipulations, starting capital and success factor, seem most closely related to fortune, and the third, probability of a successful investment or success rate, seems most closely related to luck. The average percentage of capital invested for each participant was used as a dependent variable to measure risk-taking.

At the beginning of the Huber's (1994, 1996) studies, participants were assigned to experience either a low success rate (1/3 chance of a successful investment) or high success rate (2/3 chance of a successful investment). Participants were made aware of these probabilities prior to investment decisions. Consistent with the findings of Thaler and Johnson (1990), a high success rate led to risk seeking behavior and a low success rate, led to risk averse behavior. This pattern of risk taking, as Kleiter and Wimmer (1974) have highlighted, is statistical most advantageous. Table 1 shows how the expected value of a lottery changes as a function of the probability of success. If the probability of success is high, then on average, the risk-seeking choice will return the most gain. If the probability of success is low, on average, the risk-averse choice will avoid the most loss.

However, the extent to which Huber's manipulation maps on to the present study's luck manipulation is questionable. In the current study participant knowledge of the success rate was gained through experience, making it possible for participants to experience a success rate higher or lower than what was expected. This in turn may create perceptions of luck. If participants were told they had an increased or decreased success rate, it is unlikely that participants would feel "lucky."

Table 1. Example of how changes in probability can change an unbiased gamble into favoring either risk averse or risk seeking behavior.

	Risk-Averse Choice	**Risk-Seeking Choice**
Unbiased lottery with fair chance of outcomes	1/2 chance of losing $5.00 and 1/2 chance of winning $5.00 EV= $0	1/2 chance of losing $10.00 and 1/2 chance of winning $10.00 EV= $0
Lottery biased towards better outcome	1/3 chance of losing $5.00 and 2/3 chance of winning $5.00 EV= $1.65	1/3 chance of losing $10.00 and 2/3 chance of winning $10.00 **EV= $3.30**
Lottery biased towards worse outcome	2/3 chance of losing $5.00 and 1/3 chance of winning $5.00 **EV= -$1.65**	2/3 chance of losing $10.00 and 1/3 chance of winning $10.00 EV= -$3.30

As a second manipulation in Huber's studies, participants were endowed with a starting capital of either $20 or $100. The $100 starting amount is arguably more fortunate than the $20 starting amount, but both created a starting position that is overall positive. The nature of this manipulation therefore seems most closely related to what has been described as fortune. No effect of starting amount was found, but this null effect may be due to the lack of a reference point (Birnbaum, 1999). If both low and high starting capitals are seen as equally fortunate, then it is understandable that no difference in risk taking was found.

The final manipulation, success factor, like starting capital, may also be considered more comparable to the current study's manipulation of fortune. Throughout the task, the return on each successful investment was either a doubling (success factor=1) or quadrupling (success factor=4) of the original investment. All else equal, those with the high success factor increased their capital more rapidly, improving their situation at a consistently high rate. Contrary to what Huber hypothesized, a higher success factor led to more risk-averse behavior. That is as capital

increased, participants invested a smaller proportion of their current assets. At first glance, this pattern of risk-taking may seem peculiar because both high success factor and high success rate led to increases in capital. But perhaps these differences were due to the differential effects of luck and fortune. Thus, the relatively stable increase in capital from a high success factor may operate more like fortune, and a high success rate may operate like luck. If so, it should be predicted that good fortune encourages risk-averse behaviors, whereas good luck encourages risk-seeking behaviors.

Two recent studies provide more direct evidence of possible differences in the effects of luck and fortune. In Stershic & Schneider (2013), a more pointed manipulation of fortune was conducted. The study's purpose was to study how the experience of generally positive and negative events influence risk taking. To test this, a set of control lottery pairs were surrounded by lottery pairs with either all gain or all loss outcomes. Results showed that when positive lottery pairs were in the surround, risk taking for control lotteries decreased. In the presence of negative lotteries, however, risk taking for control lotteries increased. These results provide direct evidence that fortunate experiences may support risk-averse behavior, whereas unfortunate experiences may promote risk-seeking behaviors. Such results are consistent with Huber's (1994, 1996) win factor findings, but are opposite of success rates findings, and Thaler and Johnson's (1990) house money effect. This again supports the possibility that fortune and luck may have opposite effects on risk taking.

Shortly after the Stershic and Schneider (2013) study was conducted, a pilot study was designed to directly examine the effects of luck on risk taking (Ranieri & Schneider, 2013). To manipulate luck, participants experienced an unexpected number of better or worse outcomes across a series of two-outcome lottery pairs. Participants were informed that the probability of

receiving the better outcome for any selected lottery was 50%. However, unbeknownst to the participants, the actual rate of receiving the better outcome was 75% (good luck) or 25% (bad luck). It was predicted that those in the good luck condition would take advantage of their "luck" by increasing risk taking. Likewise, those in the bad luck condition were expected to decrease risk taking to avoid the worst outcomes. Although it was not possible to document a systematic effect of luck on risk-taking, nominally the results were in the predicted direction. In retrospect, the manipulation may not have been powerful enough to elicit an effect. To redress this, the current study employed a more powerful luck manipulation.

Neurological Evidence of Luck and Fortune

Until now, evidence that luck and fortune may be distinct constructs has only been indirectly derived from studies using various positive and negative situations to examine risk taking. Although these studies are useful in hypothesizing ways in which luck and fortune may differ behaviorally, it is unclear whether luck and fortune are processed differently. Studies using neuroimaging techniques, however, can provide more direct evidence to help shed light on whether experiences of luck and fortune involve two separate processes.

Of particular interest are ERPs (event-related potentials) associated with outcome evaluation and error detection such as MFNs (medial frontal negativity). These negative ERPs are thought to be generated by the medial frontal cortex, near the anterior cingulate cortex, in response to an undesirable outcome (Potts, et al., 2006). However, there are questions about what MFNs represent. Originally, it was assumed that MFNs were sensitive to an undesired *performance*, registering when an outcome was considered "incorrect." Yet, some conjectured that MFNs might also be sensitive to an undesired *utilitarian* value, registering the negative valence of an outcome or the fact that it was a loss; however, the evidence for this has been

mixed (Nieuwenhuis et al., 2004). It may also be that each type of outcome produces a separate form of MFN. If so, the response based on performance outcomes might be more closely associated with reacting to bad luck, whereas sensitivity to utilitarian outcomes might be a response to bad fortune.

The ERN (error-related negativity) is a type of MFN that has routinely been identified as a response to incorrect outcomes. Using a time-estimation task, Miltner, Braun and Coles (1997) documented an ERN after participants incorrectly estimated the length of one second. However, the extent to which this finding can be generalized and applied to the current study is uncertain. If the ERN is sensitive to outcomes that are simply less desirable than their alternative, then an ERN may also be expected for bad luck. Though not exactly the same as an incorrect outcome, a bad luck outcome, in the current study, is always the worse of two potential outcomes. The same argument cannot be made for bad fortune because it is possible to receive a loss outcome that is also the better outcome. The question remains though, is there an MFN that is responsive to loss regardless of correctness?

Gehrig and Willoughby (2002) were among the first researchers to attempt to distinguish how outcome valence may differ from outcome "correctness" or performance. Using a two-choice, two-outcome gambling paradigm, Gehrig and Willoughby manipulated outcome valence (gain or loss) along with outcome performance (correct or incorrect). Incorrect for this study was defined as a choice which did not produce the best possible outcome. For example, making a risk averse choice in a winning gamble (because you would have done better with the riskier option) or making a risk seeking choice in a losing gamble (because you would not have done as poorly with the safer option). Outcome valence referred to whether the outcome represented a gain or a loss in earnings.

Results showed that MFN for incorrect choices were strong if the outcome was a loss but blunted if the outcome was a gain. Moreover, an MFN was also generated for correct choices if the outcome was a loss. Therefore, even if the response was correct, a negativity was still found due to the negative valence of the outcome. It was then purported by Gehrig and Willoughby that the negativity found in response to the valence of the outcome was different from the ERN, and was simply named "MFN." In the more recent literature, what Gehrig and Willoughby described as an "MFN" has typically been referred to as an FRN (feedback-related negativity). Specifically, an FRN is a type of feedback-locked MFN, which is largely associated with outcome valence (Lole et al., 2013; Martin & Potts, 2011). Nonetheless, if the FRN is responsive only to outcome valence, an FRN would be expected for all bad fortune outcomes, but not all bad luck outcomes.

However, not all of the literature exclusively associates the FRN with outcome valence. Nieuwenhuis and colleagues (2004) found an FRN for both valence and correct/incorrect outcomes, dependent on which was made more salient to the participant. When the incorrectness of an outcome was highlighted, regardless of valence, an FRN was found, but when the loss in an outcome was highlighted, regardless of correctness, an FRN was also found. It is therefore unclear whether ERNs and FRNs respond differently to different types of negative feedback, or they respond to whichever negative aspect is most salient. However, if the ERN is more related to bad luck outcomes, and the FRN is related to bad fortune outcomes, behavioral differences may also be found.

Recognizing Luck and Fortune

A primary goal of this thesis is to determine whether luck and fortune have differential effects on risk taking. In addition, it is of interest to learn whether or not participants can identify

the luck and fortune manipulations and whether they attribute the manipulations differently. To examine this, a 12-item scale was developed and named the Fortune and Luck Attribution and Identification Measure (FLAIM). The FLAIM was designed to specifically test (1) the extent to which participants can identify or recognize the fortune and luck manipulations, and (2) the extent to which they attribute their experiences to luck versus fortune. Items on this measure were presented on a continuum similar to a sematic differential scale. For example, an item aimed at measuring the identification of the fortune manipulation includes "the lotteries I received were usually bad" on one end, and "the lotteries I received were usually good" on the other end. An item meant to capture the attribution of fortune would be presented in the same fashion with "fortune was against me" versus "fortune was in my favor."

For exploratory purposes, two other well-known luck scales, the Belief in Good Luck Scale (Darke & Freedman, 1997a) and Belief in Superstition Scale (Fluke, Webster, & Saucier, 2012), were included at the end of the study. These scales have been traditionally used to measure individual differences in perceptions of luck, but might also provide insights as to how experiences of luck and fortune can affect beliefs about luck. Analyses of these measures will be conducted at a future time and will not be reported here.

Aims and Hypotheses of the Current Study

The study aims to experimentally test how manipulations of luck and fortune interact to shape risk-taking behaviors. As in the Stershic and Schneider (2013) study, two-outcome lottery pairs with all gain or all loss outcomes will surround a set of control lotteries to create a risk-taking environment that is either overall positive or negative. This will create a gambling experience that is either fortunate or unfortunate. It is expected that the good fortune manipulation will cause decreases in risk taking across control lotteries (pre-manipulation block

through manipulation block), and that the bad fortune manipulation will increase risk taking across control lotteries.

Luck will be represented by increasing the rate at which the better or worse outcome occurs after a lottery is selected to play. Increased rates of the better outcome will represent good luck and increased worse outcomes will represent bad luck. By manipulating the rate at which the better or worse outcome occurs without the participant's knowledge, a risk-taking environment with unlikely and unpredictable outcomes will be created. Similar to Huber's (1994, 1996) manipulation of success rate, it is predicted that the good luck manipulation will lead to increases in risk-taking across trials, and bad luck will lead to decreases in risk taking across trials.

In addition to gaining a better understanding of the independent effects of luck and fortune on risk taking, the proposed study is also concerned with how the experience of luck and fortune may interact to influence risk taking. Two competing hypotheses were proposed: (1) no interaction will be found, i.e., luck and fortune have additive effects or (2) a significant Luck x Fortune interaction will be found. In the case of a significant interaction it is predicted that both the worst (BF-BL) and best (GF-GL) experiences will show increased risk taking. High risk taking in the BF-BL condition may be indicative of a "desperation effect", in which participants are have no other viable option to improve their situation other than to be risk seeking (Lopes, 1986). Whereas high risk taking the in the GF-GL experience may be similar to the *house money effect* (Thaler and Johsnon, 1990). To create an optimal situation for evaluating the interaction, the proposed design is perfectly balanced within the gambling paradigm so that the monetary advantage or disadvantage of experiencing luck is equivalent to that of experiencing fortune.

This will allow for a straightforward test of the comparative strength and direction of the effects of luck and fortune on risk-taking.

As a secondary goal, the proposed study will use the newly developed FLAIM scale to explore the extent to which participants can recognize the difference between the fortune and luck manipulations, as well as to what extent participants perceive these manipulations to be luck or fortune. This aspect of the research is exploratory, and it may be that any good event will be seen as both lucky and fortunate. Just as luck and fortune are often used interchangeably in colloquial speech, it may be that participants recognize the different manipulations, but do not refer to them differentially as luck or fortune.

Methods

Participants

A total of 359 participants were recruited for the following study, 26 of these participants were excluded for incomplete data and/or technical difficulties. In order to evaluate participants' understanding of the lottery task, an eight-question quiz was given at the beginning of the study. This quiz was dual-purposed. It tested both the understanding of the lottery task, and served to detect participants who may have been rushing through or not paying attention to the lotteries. Data for those missing more than one question on the quiz were excluded from analysis.

Of the 333 participants left approximately 1/3 failed to pass the preliminary 8 question. This left 233 (165 females) usable participants for analysis. All participants accessed the study through the University of South Florida's SONA System, an online study participation site. In exchange for participation, participants received extra credit in a psychology course.

Stimulus Sets

Stimuli included four sets of lottery pairs: a control set, a good fortune set, a bad fortune set and a mixed fortune set. All possible values for lottery pairs are shown in Table 2. Gambles within each pair had the same expected value, but differed in variance. The lottery with the greater difference between outcomes was considered the high risk lottery, and the lottery with the smaller difference was considered low-risk (Lopes, 1987). Two levels of variance were presented for both high and low risk lottery pairs. High risk lotteries had outcome differences of either $200 (high variance) or $100 (low variance). Low risk lotteries had outcome differences of

either $100 (high variance) or $50 (low variance). *Control set.* The control set consisted of 10 unique two-outcome lottery pairs, and was created using a 2x5 Variance x Expected Value framework. The two levels of variance were low and high, and the five levels of expected value were -$50, -$25, $0, $25, and $50. As shown in Table 2, all lotteries pairs in the control set were repeated twice except for those with an expected value of 0. Therefore the control set consisted of a total of 18 lottery pairs. In addition, this set was designed so that after the entire set had been played, the expected net change in earnings was $0.

Good Fortune, Bad Fortune, & Mixed Fortune Sets. Each of the fortune sets consisted of 12 two-outcome lottery pairs, and was created using a 2x6 Variance x Expected Value framework. Levels of variance remained the same as in the control set (high and low). Expected values for lottery pairs in the good fortune set were all gains and ranged from $100 to $200 increasing by increments of $25. Expected values for the lottery pairs in the bad fortune set were all loss and ranged from -$100 to -$200 decreasing by increments of $25. The mixed fortune set contained 6 lottery pairs from the good fortune set and 6 from the bad fortune set. Gamble pairs selected for the mixed fortune set were counterbalanced to ensure equal representation of expected values and variances from the bad and good Fortune sets. As seen in Table 2, expected values for the mixed fortune set ranged from -$200 to $200 with an equal number of high and low variance lottery pairs. Like the control set, the expected net gain after all lotteries from the mixed fortune set had been played was $0.

Table 2. Stimulus lottery pairs

EV (50/50)	VARIANCE	HIGH-RISK GAMBLE		LOW-RISK GAMBLE		CONTROL SET*	FORTUNE SETS	MIXED SET
		Worse Outcome	Better Outcome	Worse Outcome	Better Outcome			
-200	Low	-$275	-$125	-$225	-$175		BF	
-200	High	-$300	-$100	-$250	-$150		BF	MIXED
-175	Low	-$250	-$100	-$200	-$150		BF	MIXED
-175	High	-$275	-$75	-$225	-$125		BF	
-150	Low	-$225	-$75	-$175	-$125		BF	MIXED
-150	High	-$250	-$50	-$200	-$100		BF	
-125	Low	-$200	-$50	-$150	-$100		BF x2	MIXED
-125	High	-$225	-$25	-$175	-$75		BF x2	MIXED
-100	Low	-$175	-$25	-$125	-$75		BF	
-100	High	-$200	$0	-$150	-$50		BF	MIXED
-50	Low	-$125	$25	-$75	-$25	CON x2		
-50	High	-$150	$50	-$100	$0	CON x2		
-25	Low	-$100	$50	-$50	$0	CON x2		
-25	High	-$125	$75	-$75	$25	CON x2		
0	Low	-$75	$75	-$25	$25	CON		
0	High	-$100	$100	-$50	$50	CON		
25	Low	-$50	$100	$0	$50	CON x2		
25	High	-$75	$125	-$25	$75	CON x2		
50	Low	-$25	$125	$25	$75	CON x2		
50	High	-$50	$150	$0	$100	CON x2		
100	Low	$25	$175	$75	$125		GF	MIXED
100	High	$0	$200	$50	$150		GF	
125	Low	$50	$200	$100	$150		GF x2	MIXED
125	High	$25	$225	$75	$175		GF x2	MIXED
150	Low	$75	$225	$125	$175		GF	
150	High	$50	$250	$100	$200		GF	MIXED
175	Low	$100	$250	$150	$200		GF	
175	High	$75	$275	$125	$225		GF	MIXED
200	Low	$125	$275	$175	$225		GF	MIXED
200	High	$100	$300	$150	$250		GF	

*Note.**The same control stimuli were seen in all three blocks; however, the experienced choice outcomes deviated from the 50/50 expected values in the two manipulation blocks according to type of luck . EV= Expected Value, CON= Control Set, BF= Bad Fortune Set, GF= Good Fortune Set, MIXED= Mixed Fortune set, x2= lottery pair presented twice.

Design

The current experiment was created using a 2x3x3 Luck x Fortune x Block mixed factorial design with Block as the within-subjects variable. The 2x3 Luck x Fortune factorial created the six between-subjects conditions: Good Luck-Good Fortune (GL-GF), Good Luck-Mixed Fortune (GL-MF), Good Luck-Bad Fortune (GL-BF), Bad Luck-Good Fortune (BL-GF), Bad Luck-Mixed Fortune (BL-MF), and Bad Luck-Bad Fortune (BL-BF). Participants were randomly assigned to one of these six conditions and played through 66 lottery pairs over the course of three blocks.

The first block, Block 1, served as a pre-manipulation control block and consisted of the 18 Control set lottery pairs. To ensure similar and neutral experiences in Block 1, the outcomes of each lottery pair were fixed to produce an equal number of better and worse outcomes. This ensured a 50% success rate and an overall expected net gain of $0.

Manipulations of luck and fortune were implemented in Blocks 2 and 3 (the manipulation blocks). In each of these blocks the set control lottery pairs were presented in a mixed order along with one of Fortune set lottery pairs. The fortune set added determined the fortune manipulation (good, mixed or bad). Luck was manipulated by increasing (good luck) or decreasing (bad luck) the rate at which participants received the better outcome, or success rate, of a given control lottery.

As depicted in Table 3, Block 2 contained half of the Fortune lottery pairs (6 lottery pairs) and Block 3 contained the other half of the lottery pairs from that set. However, both blocks featured the control set, in full. Thus, blocks 2 and 3 contained 24 lottery pairs each. Fortune set lotteries were presented in a varied order combined with the control set lotteries so that roughly one of every four lottery pairs was from the fortune set.

Luck was manipulated by changing the probability of better outcomes or "success rate" of the control lotteries in blocks 2 and 3. Success rates of Fortune lotteries remained 50/50 in all cases. Although participants were informed that all lottery pairs were fair (i.e., 50% success rate), those in the good luck condition experienced an 89% success rate for control set lotteries in Blocks 2 and 3, and those in the bad luck condition experienced an 11% success rate. To ensure that each participant received the better (or worse) outcome in exactly 89% of the control set lotteries, 16 of 18 lottery pairs in blocks 2 and 3 were fixed to always produce the better (or worse) outcome. The remaining two were fixed to produce the reverse.

Table 3. Fortune and luck manipulations by block

Block 1	**Block 2**	**Block 3**
Control Set (18 lottery pairs w/ 50/50 success rate)	**Control Set w/ Luck Manipulation** [18 lottery pairs w/ unexpectedly high (GL) or low (BL) experienced success rate] + **½ Fortune Set** [6 Gamble Pairs w/ all positive outcomes (GF), all negative outcomes (BF) or a mixture (M) of both]	**Control Set w/ Luck Manipulation** [18 lottery pairs w/ unexpectedly high (GL) or low (BL) experienced success rate] + **½ Fortune Set** [6 Gamble Pairs w/ all positive outcomes (GF), all negative outcomes (BF) or a mixture (M) of both]

A primary goal of this design was to compare, as fairly as possible, the effects of fortune versus the effects of luck on risk taking. As explained by Cooper & Richardson (1986), in order to justly compare two manipulations, both manipulations need to be comparable in strength. With that in mind, it was a priority of the current study to balance the luck and fortune manipulations. Therefore the advantage of having good fortune was made to be equivalent to the

advantage of having good luck (expected value of $1,750). In turn, the disadvantage of bad Fortune was made to be equivalent to the disadvantage of bad luck (expected value of -$1,750). Table 4 illustrates this by showing the expected net earnings for each condition.

Table 4. Average expected values of each of the between-subjects conditions

	Expected Net Earnings: Good Fortune	**Expected Net Earnings: Mixed Fortune**	**Expected Net Earnings: Bad Fortune**
Good Luck	$3,500	$1,750	$0
Bad Luck	$0	-$1,750	-$3,500

The primary dependent variable of this study was the number of times the participant chose to play the high-risk lottery out of the 18 lottery pairs in the Control set. Although lottery selections were recorded for every lottery pair, the Control set lotteries were of particular interest because they can be compared to equivalent lottery pairs across blocks. This allowed us to map how risk-taking behavior changed from the pre-manipulation block through the end of the manipulation blocks.

Included at the end of the study was the Fortune Luck Attribution and Identification Measure, or FLAIM. The purpose of the scale was to determine how luck and fortune manipulation were perceived and recognized by participants. As there was no previously validated scale to measure subjective experiences of luck and fortune, the scale was created specifically for this experiment.

The FLAIM included four subscales; (1) attributed luck, (2) identified luck, (3) attributed fortune, and (4) identified fortune, each with 4 items. Each item had a 5-point scale, with two opposing phrases on each side of the scale, similar to a semantic differential scale. Participants then rated the degree to which they agreed with either the left or right statement. Items were

created using face-valid phrases such as, “I feel that the odds were against me” versus “I feel the odds were in my favor.” A copy of the full FLAIM scale can be found in Appendix I.

Previously used measures of luck such as, the Belief in Good Luck Scale (BIGL) and Belief in Superstition Scale (BSS) were also included for exploratory purposes. In addition a free-response section, and gender demographic question was included at the end of the study for the purpose of gathering qualitative data to potentially gain insight into participants’ decision-making strategies. This included a question aimed at assessing the degree to which participants suspected their performance was influenced by experimenter manipulation. However, no explicit evidence of suspicion was detected, therefore no action was necessary.

Procedure

Participants were able to sign up and participate for the study entirely online. Once the participant read and agreed to the online informed consent, he or she was directed through a series of practice lotteries with instructions, followed by the 8 question quiz used to assess participants’ knowledge of the lottery task.

In the primary task, participants played through 3 consecutive blocks of lottery pairs which totaled to 66 lottery pairs. To play, participants selected one of the two possible lotteries presented, and then the computer chose which of the two outcomes would be added or subtracted from their current total. Figure 1 is an example of how the lottery pair was presented to the participants. After the last lottery was played, participants completed the FLAIM scale as well secondary luck questionnaires, free response items, and a demographic question. Completion of these items marked the end of the experiment. Participants were then thanked, and assigned class credit for participation.

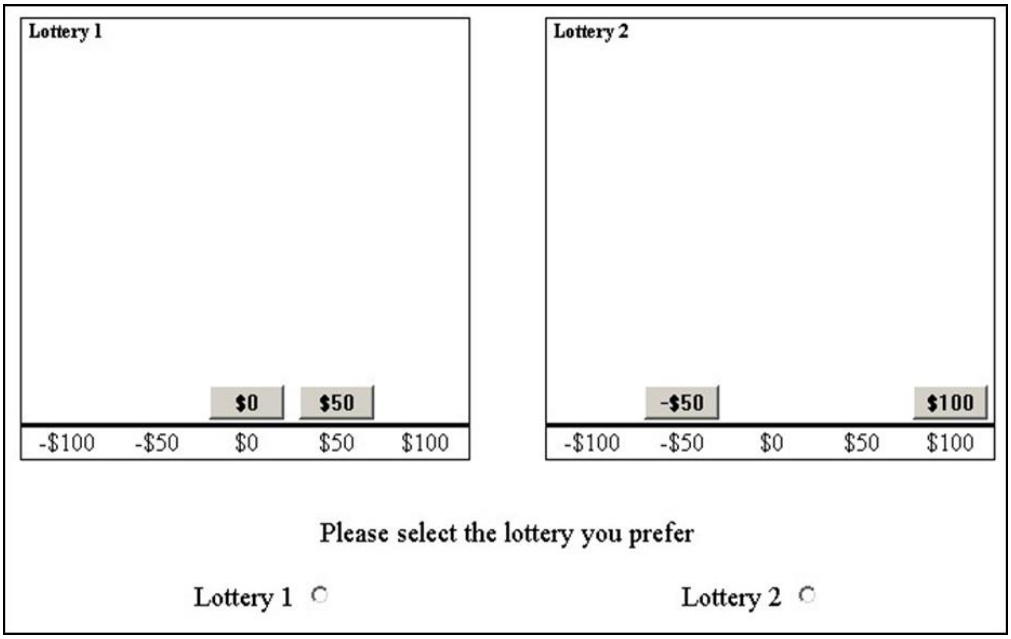

Figure 1. Example of a single Control set lottery pair.

Results

In order to fully analyze the effects of luck and fortune on risk taking, and to explore the extent to which luck and fortune were experienced differently by participants, analyses were divided into two major sections. The first section consisted of a mixed ANOVA evaluating how the luck and fortune manipulations affected risk taking across the three blocks of lotteries. A follow-up analysis was then conducted looking exclusively at the effects of luck and fortune on risk taking in Block 3, when participants would have had the greatest exposure to the manipulations. The second section includes a series of tests of the FLAIM subscales to determine whether participants could differentiate the luck and fortune manipulations, and whether these manipulations were differentially attributed to luck and fortune.

Evaluation of Luck and Fortune Manipulations

Overall Effects of Luck and Fortune on Risk-Taking Behavior. To examine the effects of fortune and luck on risk-taking behavior across the entire experiment, a 2x3x3 Luck x Fortune x Block mixed factorial ANOVA was conducted. The primary dependent variable was the number of times the riskier lottery was selected out of the set of 18 control lotteries. Risk-taking scores therefore ranged from 0 (no risks taken) to 18 (every risk taken).

It was predicted that a main effect would be found for both luck and fortune, with good luck and bad fortune increasing risk taking, and bad luck and good fortune decreasing risk taking. However, neither effect was found. The main effect of fortune approached significance

$F(2,227)=2.90$, $p=.057$, partial $\eta^2=.025$, but that of luck did not, $F<1$. Consistent with previous research (Stershic et al., 2013), a significant main effect was found for block, $F(2,454)=8.36$, $p<.001$, partial $\eta^2=.036$, involving a slight increase in risk taking across blocks

Because the pre-manipulation block was averaged into the main effects for luck and fortune, any potential effects of these variables may have been muted. Thus, the interactions involving block were the more crucial tests of the effects of luck and fortune. As predicted, a Fortune x Block interaction was found which qualifies the previous main effect findings, $F(4,454)=8.22$, $p<.001$, partial $\eta^2=.068$. The interaction is depicted in Figure 2. As expected, participants in the good fortune condition had a tendency to decrease risk taking for the control lotteries across blocks, whereas those in the bad fortune condition increased risk taking across blocks. Those in the mixed fortune condition showed little change in risk taking across blocks. Simple effects analysis of fortune at Block 1 confirmed that that there were no differences in risk taking between fortune conditions prior to the manipulation, $F<1$. Simple effects analysis for fortune at Blocks 2 and 3, however, were significant, $F(2,330)=4.10$, $p=.02$, partial $\eta^2=.024$ and $F(2,330)=17.02$, $p<.001$, partial $\eta^2=.093$, respectively, with effect size increasing from Block 2 to Block 3. This pattern is confirmed by observing Figure 2.

Based on previous research manipulating success rates (e.g., Huber 1994, 1996), an increase in risk-taking behavior across blocks was expected for the good luck manipulation, coupled with a decrease in risk taking for bad luck. However, no such Luck x Block interaction was found, $F(2,454)=1.94$, $p=.15$, partial $\eta^2=.008$. The absence of such a relationship is provocative because, unlike fortune, luck can substantially impact total net earnings depending on risk-taking behavior.

Figure 2. Fortune x Block interaction on risk risking.

The final interactions of interest were the Luck x Fortune interaction and the Luck x Fortune x Block interaction. Two alternative hypotheses were made to predict the relationship between luck and fortune; one which predicted that luck and fortune would have additive effects, and another which described an interaction that would create both a *desperation effect* and a *house money effect* in Block 3. However, no such interaction was found, $F<1$, nor was there evidence of a 3-way interaction, $F(4,454)=1.87$, $p=.11$, partial $\eta^2=.016$.

Examination of Block 3: Luck, Fortune, Risk, and Net Earnings. The next analyses more closely examined the fortune and luck effects in Block 3. This last block was of particular interest because it was expected that the effects of fortune and luck would have reached their peak. By the end of Block 3, participants would have seen all 12 fortune lotteries, and would have experienced the entirety of the luck manipulation. In addition, it is within Block 3 that the strength of the luck and fortune manipulations would be most balanced. Due to the design of the experiment, the net gain (or loss) caused by the luck manipulation with an increase (or decrease)

of better outcomes for the control lotteries either completely offsets or doubles the net gain (or loss) of the good and bad fortune lotteries by the end of Block 3.

Although the overall effect of fortune was established in the primary analysis, a second 2 x 3 Luck x Fortune ANOVA in Block 3 was conducted to analyze the luck and fortune manipulations at their maximum strength. If luck did have any behavioral effects on risk taking, it would most likely be revealed in this analysis. Still, consistent with the interpretation of the primary analysis, no effect for luck was found, $F<1$, nor was an interaction present, $F<1$. Just a single main effect for fortune was found, $F(2,227)=8.64$, $p<.001$, partial $\eta^2=.071$. Thus, even with the most revealing test, we found no evidence that the luck manipulation influenced risk-taking behavior. As seen in Figure 3, risk taking does not differ depending on whether the participants experienced good or bad luck; however, good fortune was associated with less risk taking and bad fortune with more risk taking.

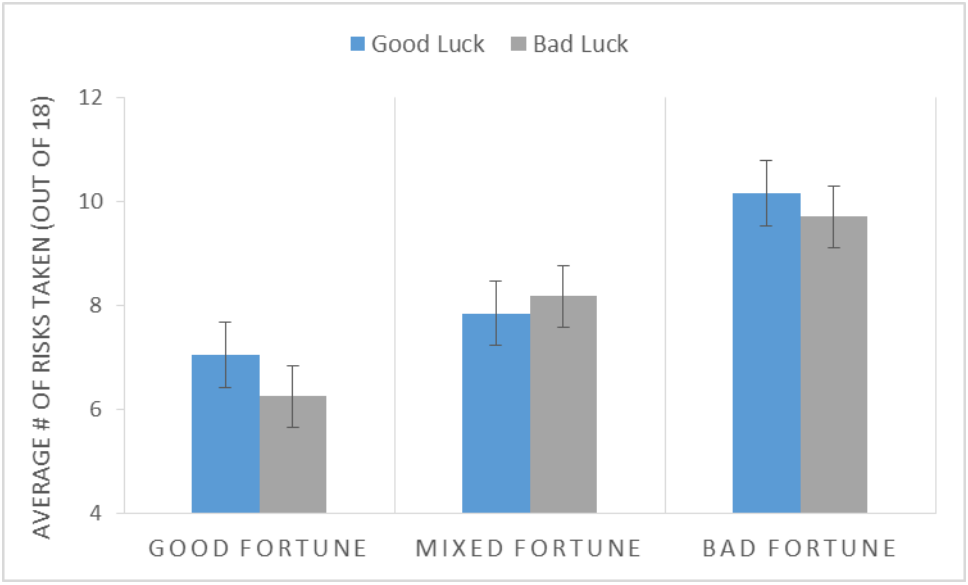

Figure 3. Fortune x Luck interaction on average number of risks taken in Block 3.

In order to check that each manipulation was executed as intended, actual net earnings for each condition were compared to average expected values. Table 5 shows the average expected values for each condition paired with the observed average net earnings in bold (less the original endowment of $1,250). Some deviations between expected and actual net earnings were inevitable due to differences in risk-taking preferences within each condition; nevertheless, the observed average net earnings for participants closely approximated the expected values for the conditions.

Table 5. Average expected net earnings in Block 3 alongside actual net earnings in Block 3

	Good Fortune		**Mixed Fortune**		**Bad Fortune**	
	Expected	**Observed**	**Expected**	**Observed**	**Expected**	**Observed**
Good Luck	$3,500	**$3,280**	$1,750	**$1,672**	$0	**$55**
Bad Luck	$0	**$163**	-$1,750	**-$1,593**	-$3,500	**-$3,389**

As can be seen in Table 5, there are two conditions that were carefully manipulated to have equal expected net earnings, BF-GL and GF-BL, so that we could potentially rule out differences in assets as a primary explanation for observed differences in risk taking. A t-test comparing average net earnings confirmed that earnings were roughly comparable between these groups, $t(77)=1.50$, $p=.14$, $d=.33$. However, the same two conditions vary greatly on risk taking in Block 3, $t(77)= -3.68$, $p<.001$, $d=.82$. (See Figure 3.) Indeed, these are the two most disparate condition means for risk taking. This provides strong evidence that differences in net earnings cannot be the primary cause of the observed differences in risk-taking behaviors.

Identification and Attribution of Luck and Fortune

Using a combination of ANOVAs and correlations, responses from the FLAIM scale were analyzed to evaluate the degree to which participants could identify the luck and fortune manipulations and to determine whether these manipulations were attributed to luck and/or fortune. Subscales included: (1) *identification of luck,* which consisted of face valid statements aimed at determining whether participants recognized having a higher proportion of better or worse lottery outcomes across the study, (2) *identification of fortune,* which used similar statements to determine if participants perceived a higher proportion of positive or negative lottery pairs, (3) *attribution of luck* and (4) *attribution of fortune,* which was aimed at determining whether participants would semantically differentiate the terms "luck" and "fortune." (See Appendix A for the complete set of items.)

Prior to the main analyses, reliability and correlational analyses were conducted within and between FLAIM subscales. Reliability analyses confirmed high inter-item reliability within each subscale, with Cronbach's α ranging from .80 to .92. However, a strong relationship also existed between the four subscales.

A substantial overlap between identification subscales suggested that participants did not recognize that luck and fortune were separate manipulations, $r(230)=.84$, $p<.001$. Those who reported having a higher proportion of better outcomes also reported getting a higher proportion of positive lotteries., Similarly, attributions of luck and fortune were not differentiated, $r(231)=.94$, $p<.001$. Those who reported being "fortunate" also reported being "lucky."

Due to this lack of differentiation, subscales with conceptually similar items were combined to create two broader dependent variables, *identification* and *attribution*. Scores for

these two combined dependent variables therefore ranged from -16 (complete negative endorsement) to +16 (complete positive endorsement) with 0 indicating no endorsement.

Identification of Luck and Fortune. To analyze the effects of the luck and fortune manipulations on identification, a 2x3 Luck x Fortune ANOVA was conducted. A significant main effect for fortune was found, $F(2,226)=29.56$, $p<.001$, partial $\eta^2=.207$. Participants who experienced good fortune endorsed statements consistent with believing they had experienced both a higher proportion of positive lotteries and a higher proportion of better outcomes (M=2.19, SEM=0.65). Similarly, those who experienced bad fortune provided negative endorsements consistent with believing they experienced a higher proportion of negative lotteries and a higher proportion of worse outcomes (M= -4.80, SEM=0.64). Those with mixed fortune had endorsements averaging close to zero (M= -1.55, SEM=0.63).

A second, even larger, main effect was found for luck, $F(1,226)=189.16$, $p<.001$, partial $\eta^2=.456$. This was somewhat surprising given that luck had no effect on risk taking. Participants who experienced good luck endorsed statements consistent with receiving more positive lotteries and better outcomes (M=3.67, SEM=0.53), and those who experienced bad luck endorsed statements consistent with receiving more negative lotteries and worse outcomes (M= -6.45, SEM=0.51). No interaction between luck and fortune was present, $F(2,226)=1.72$, $p=.18$, partial $\eta^2=.015$.

Although all identification items were written to describe the fortune-based lottery pair valence, or the luck-based proportion of better outcomes, it is possible that participants were more sensitive to whether the eventual outcomes they received from playing the lotteries were gains or losses. Because the luck manipulation was present only in the control lotteries, which were mixed in valence, the *better* outcome was often synonymous with a gain, and the worse

outcome with a loss. Those in the good luck conditions, therefore, did experience more gain outcomes than those in the comparable bad luck conditions. Table 6 shows the number of good fortune lotteries and better outcomes in Blocks 2 and 3, alongside the number of gain outcomes and net earnings experienced. Although the manipulations were carried out as intended, their combined effect necessarily created substantial differences in the number of gain outcomes experienced.

Table 6. Number of good fortune lottery pairs, better outcomes, positive outcomes and net earnings by experience condition.

Experience	# Good Fortune Lottery Pairs	# Better Outcomes	# Gain Outcomes	Net Earnings
GF-GL	12	38	39.80	$3,280
MF-GL	6	38	34.32	$1,672
BF-GL	0	38	28.85	$55
GF-BL	12	10	19.61	$163
MF-BL	6	10	12.35	-$1,593
BF-BL	0	10	6.18	-$3,389

Note: GF= Good Fortune, MF= Mixed Fortune, BF=Bad Fortune, GL= Good Luck, and BL=Bad Luck.

In order to test whether the number of gain outcomes experienced could account for the variation in identification scores, a correlation between the number of gain outcomes experienced in Blocks 2 and 3, and identification scores was conducted, $r(230) = .73$, $p < .001$. The large correlation suggests that identification of luck and fortune was primarily a product of the number of gain outcomes that resulted, which is a combined function of the number of positive lotteries seen, and the number of better outcomes experienced. This close match between number of gain outcomes and identification (as well as attribution) scores is illustrated in Figure 4.

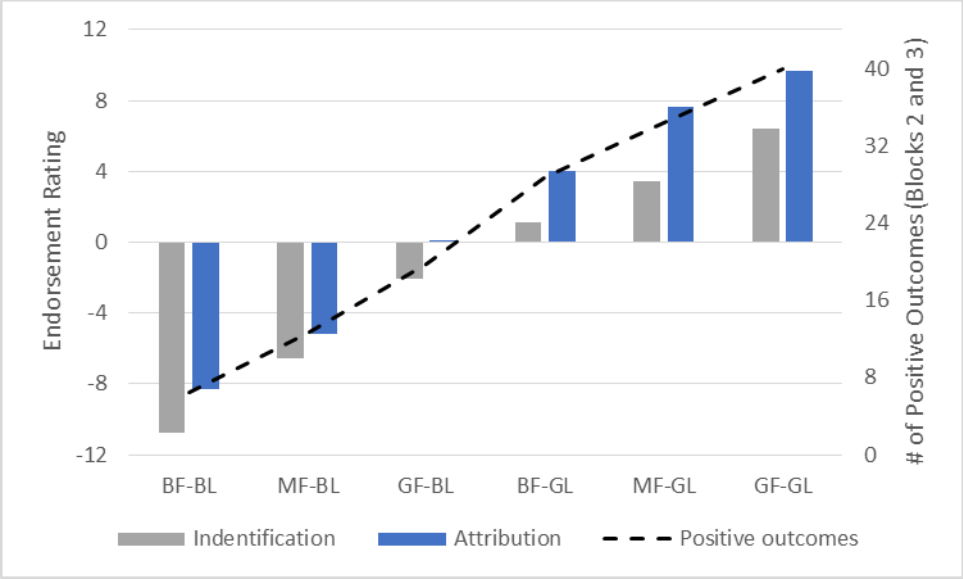

Figure 4. Identification scores, and attribution scores plotted across each experience condition. The black dotted line represents the total amount of positive outcomes experienced in Blocks 2 and 3.

A second promising predictor of identification scores was net earnings; however, just as net earnings could not explain risk taking, it also failed to explain the difference in endorsements for conditions with comparable net earnings, i.e., GF-BL and BF-GL. For both identification, $t(77)= -2.57$, $p=.012$, and attribution measures, $t(77)= -2.73$, $p= .008$, the condition with a higher number of gain outcomes (BF-GL) was found to have significantly higher endorsement scores than the condition with less gain outcomes (GL-BF).

Attribution of Luck and Fortune. The 2 x 3 Luck x Fortune ANOVA on attribution ratings yielded findings almost identical to those for identification. A main effect for fortune was found, $F(2,227)=22.91$, $p<.001$, partial $\eta^2=.168$, as well as an even larger main effect for luck, $F(1,227)=190.47$, $p<.001$, partial $\eta^2=.456$. Both good fortune (M=4.90, SEM=.74) and good luck (M=7.14, SEM=.61) manipulations led to positive endorsements of statements describing their overall lottery experience as "lucky" and "fortunate." Correspondingly, the bad fortune (M= -2.16, SEM=.73) and bad luck (M= -4.48, SEM=.58) manipulations led to negative

endorsements consistent with having an overall "unlucky" and "unfortunate" lottery experience. Those in the mixed fortune experience had slightly positive endorsements, (M=1.24, SEM=.72) suggesting their overall experience was rated as marginally lucky and fortunate.

However, like the identification scores, a strong positive relationship existed between the number of gain outcomes experienced and the degree to which participants rated their lottery experience as lucky and fortunate, $r(231) = .72$, $p < .001$. It is therefore likely that the variations seen in attribution score are most closely tied to the number of gain outcomes experienced. As seen in Figure 4, those with more gain outcomes endorsed statements that described being lucky and fortunate, whereas those with fewer gain outcomes endorsed statements which described being unlucky and unfortunate.

Ultimately, it seems that participants tended to recall their lottery experiences in terms of the valence of lottery outcomes, and were not sensitive to whether that outcome was the result of simply having a pair of good lotteries or the result of winning the better outcome in a mixed lottery pair. Both generally resulted in a gain outcome. Likewise, terms involving "luck" and "fortune" were used for both luck and fortune manipulations, but were closely tied to the number of gain outcomes experienced by participants, regardless of how they came about.

Though our evidence suggests that participants use an undifferentiated accounting of the valence of their outcomes to remember and describe their experience afterwards, the valence of experienced outcomes cannot explain how participants chose which lottery to play. No relationship exists between the number of gain outcomes experienced and the number of risks taken in Block 3, $r(231)=.03$, $p=.70$. The number of risks taken is instead best explained only by the fortune manipulation, which determined the valence of surrounding lottery pairs, and not at all by the luck manipulation, which determined whether better or worse outcomes predominated.

Discussion

The goals of the current study were to (1) examine how luck and fortune interact to shape risk taking behaviors, and (2) establish whether luck and fortune were differentiated as separate constructs. Replicating Stershic and Schneider (2013), a systematic effect on risk taking was found for fortune. Bad fortune resulted in increased risk taking and good fortune resulted in decreased risk taking. Yet, contrary to our hypothesis, no effect was found for luck. Despite having the same expected impact on net earnings as fortune, there was no evidence to suggest that bad or good luck had any influence on risk taking. This is especially curious given that both the luck and fortune manipulations contributed to post-experimental subjective experiences of luck and fortune, even though neither manipulation was distinguished from the other.

In what follows, we will first discuss participants' ability (or inability) to distinguish between the luck and fortune manipulations. We will then discuss how different types of gains and losses can affect risk taking by comparing the current study's results to that of Huber (1994; 1996), and Thaler and Johnson (1990). Next, we will focus specifically on how luck (i.e., better/worse probability), fortune (i.e., positive/negative context), net earnings, and gain outcomes relate to risk taking and subjective experiences of luck and fortune. Finally, we will address the implications of our findings in developing advantageous risk strategies, as well as limitations and future directions.

Not All Positives are Created Equal

It was not especially surprising to find that attributions about the terms "luck" and "fortune" were used interchangeably. Unexpected, however, was that participants seemed largely insensitive to differences between how luck and fortune functioned. Participants did not distinguish between gains as a result of good context and gains as a result of better outcomes. Instead, any gain was seen as a result of both good luck and good fortune, and any loss was seen as a result of both bad luck and bad fortune.

Yet despite the apparent lack of differentiation between changes in positive context and probability of success, participants did respond differently to the manipulations in terms of their risk taking. A better context (good fortune) served to decrease risk taking, whereas a poorer context (bad fortune) served to increase risk taking. Good luck and bad luck, however, did not have any influence on risk taking. This does not mean, however, that risk taking is only affected by changes in context. Instead, this may serve as one example of how differences in the way gains and losses are attained can influence a decision maker's willingness to take risks. Here, when most of the options tend to have positive outcomes, people respond by decreasing risk taking, but they do not change their behavior when experiencing a preponderance of better outcomes. These differences in how outcomes are obtained may help explain why past studies using lottery-based paradigms have found conflicting evidence on whether past gains work towards encouraging or discouraging risk taking (e.g., Huber, 1994, 1996; Thaler & Johnson, 1990).

It was first hypothesized that these differences in risk taking patterns might be explained by the differential roles of fortune and luck. However, given that luck was not found to impact risk taking, this conclusion cannot be verified. Instead, these incongruities may be due to

differences in how the gains (and losses) were attained which are not reflective of luck or fortune. In the current study, for example, participants played through a series of sequential lotteries in which each lottery outcome was added or subtracted from a current running total. Each gain or loss was therefore a product of a previous decision. This setup may have contributed to a single, larger, lottery experience that which may have developed a context that was gradually more positive or negative. In Thaler and Johnson's (1990) study, however, gambles were played in two steps, making each lottery inherently disconnected from each other. Rather than have a loss or gain as a result of a previous choice, Thaler and Johnson endowed their participants with either a gain or loss. A disconnect such as this may have hindered the ability of participants to develop a larger sense of the lottery context. In turn, this may explain why the risk taking pattern observed in the current study was not observed by Thaler and Johnson.

Huber's (1994, 1996) paradigm was closer to what was used in the current study, yet the results were not completely congruent. Consistent with our fortune results, Huber found that as earnings increased, risking taking decreased. Likewise, as earnings decreased, risk taking increased. This led him to the conclusion that as the situation becomes more favorable, the need to take risks decreases. This explanation, however, cannot account for why earnings due to good luck in our study did not decrease risk taking, or why bad luck did not increase risk taking.

Though elements of both luck and fortune existed in Huber's studies, the two effects were confounded, as they typically are in real life. The overall positivity or negativity of the lottery context was determined by the amount of earnings, which was directly related to the probability of a successful investment. Therefore the effect of context, probability of success, and net earnings on risk taking could not be separated. In the current study however, these three

factors were isolated. Only surrounding context was found to impact risk taking, and not probability of success, or net earnings. As demonstrated in the BF-GL and GF-BL conditions, more risks were taken in the condition with the more negative context (BF-GL), even though the conditions had similar net earnings. It is therefore possible that the results found in the Huber studies are also driven by changes in overall positivity and negativity, and not by a high or low probability of winning, or total net earnings per se.

The Role of Outcome Valence in Risky Decision Making

Though fortune was the only factor which appeared to influence risk taking, the combined effects of luck and fortune were found to have strong additive effects on the amount of subjectively experienced luck and fortune. Both identification and attribution of luck and fortune were tightly linked to the combined effects of the luck and fortune manipulations. However, because participants were unable to differentiate between luck and fortune, there was no direct evidence to suggest that participants actually recognized a change in success rate, or that they were surrounded by more positive or negative lottery pairs. Instead, changes in subjective experiences of luck and fortune may have been in response to a more proximal joint effect of the luck and fortune manipulations.

The combination of luck and fortune largely determined both net earnings, and the *number* of gains experienced in the study. As net earnings increased, so did subjective perceptions of luck and fortune, except in two cases. Participants in the BF-GL condition perceived themselves to have been more fortunate and luckier than those in the GF-BL condition, despite having equal net earnings. The BF-GL, however, had more frequent smaller gains, whereas GF-BL had fewer but larger gains. Therefore the patterns found in subjective

experiences of luck and fortune more closely match changes in number of gains, and not changes in net earnings.

Ultimately, the number of gain outcomes was found to be the best predictor of subjective experiences of luck and fortune, accounting for almost half of the variance. The more gain outcomes experienced, the more good luck and good fortune participants reported having. The finding that a higher number of gains led to an increased sense of luck and fortune is consistent with the *somatic marker* hypothesis (Damasio, 1995). For each outcome experienced, a positive or negative affective marker may have been associated with the valence of the outcome. Thereby, gains would produce positive somatic markers and losses would produce negative somatic markers. With each gain and loss experienced, this pairing would be reinforced, making more gain outcomes feel like a more positive experience overall and more loss outcomes feel more negative overall. The somatic marker explanation also fits well with Thaler and Johnson's (1990) *hedonic editing hypothesis*, which suggests that several smaller gains are preferable to and experienced as more pleasurable than a single gain of equivalent combined value. Consistent with both perspectives, the positive and negative reactions associated with the proportion of gain and loss outcomes may have served as the primary determinant of the amount of luck and fortune subjectively experienced in the study.

The Differential Effects of Fortune and Luck on Risk Taking

A critical question that has yet to be answered is why fortune, but not luck, influences risk taking. Both manipulations served to better or worsen the lottery task in comparable ways, yet only changes in lottery context affected risk taking. Differences in the proportion of better or worse outcomes did not influence risk taking, even though the luck manipulation indirectly had a large effect on the experience of luck and fortune. In addition, the luck manipulation, not fortune,

allowed for improvement of net earnings through risk-taking strategy. A risk-seeking strategy when experiencing good luck would increase net gains, whereas a risk-averse strategy when experiencing bad luck would lessen net losses.

One possibility is that the fortune manipulation was more salient than the luck manipulation when choosing between options. Such a difference in attentional emphasis has recently been discussed in Huber's (2012) risk-management-decision theory (RMDT). Huber argues that decision makers are less concerned about the probability of outcomes because probabilities may not always be reliable, not always available, and are not always needed (e.g., heuristic-based decisions). More essential to the decision process is the valence of potential outcomes.

Looking first at lotteries with all loss or all gain outcomes (i.e., fortune lotteries), we find risk taking patterns that are quite consistent with prospect theory (Kahneman and Tversky, 1979). Risk-averse behavior is seen for lotteries with all gain outcomes (good fortune), and risk-seeking behavior is seen for lotteries with all loss outcomes (bad fortune). Prospect theory, however, cannot account for why we also see changes in risk taking in the control lotteries for these conditions. Given that most of the control lotteries were mixed in valence, a contrast effect (e.g., Simonson & Tversky, 1992) might have been expected. A contrast between the fortune and control lotteries would have presumably exaggerated their differences. Good fortune would make the mixed-outcome control lotteries seem more negative leading to increased risk seeking, and bad fortune would make the control lotteries seem more positive leading to increased risk aversion. Instead, we observed the opposite trend wherein risk taking decreased in control lotteries surrounded by good fortune lotteries, and risk taking increased in control lotteries surrounded by bad fortune lotteries.

Instead of a contrast effect, risk taking patterns for control lotteries became more similar to the fortune lotteries. It is possible that viewing a predominance of positive or negative lottery pairs may have shifted attention toward different kinds of goals. Lopes (1986), for instance, argued that changes in *aspiration* often occur in response to situational factors. For example, if the situation is generally positive, as in the case of good fortune, attention may be focused on maintaining the status quo. The goal in this situation would be to seek *security*, thus promoting risk-averse behaviors. But if the situation is generally negative, as it is in bad fortune, attention may be focused on returning to a better situation by recovering from losses. The goal in this situation would then be to seek *potential*, thus promoting risk-seeking behaviors.

This explanation suggests that the positive/negative context of the lottery task as determined by the fortune condition influenced the salience of different goals across all of the pairs within the risky choice task. Seeing several all-positive lotteries may "set the tone" for thinking about maintaining security and seeing many all-negative lotteries may highlight the importance of pursuing the very best outcomes which are only available in the riskier options. Thus, the context represented by fortune may have had the effect of shifting the focus toward maintaining security or toward chasing the potential for recovery. Luck however, did not have the same influence.

In situations where there is a clear positive or negative context, luck may be less influential on how people make choices, and more related to how the experience is evaluated one the choice or task is complete. The experience of luck seems to have less to do with likelihoods than with the occurrence of gain outcomes, no matter how they come about. And, in these situations, the value of differences in likelihood, if separated from good versus bad outcomes, seems to be completely missed as a means of improving decision making.

Limitations and Future Directions

The finding that participants are responsive to fortune, but not luck, in regards to risk taking is somewhat troublesome. Regardless of what risk strategy a participant uses, the expected net gain for the fortune manipulation remains about the same. Expected net earnings from the luck manipulation, however, are largely dependent on the risk strategy used. A risk-seeking strategy for good luck would result in increased net earnings, whereas a risk-averse strategy for bad luck would result in smaller decreases in net earnings. The fact that participants are insensitive to this type of information suggests lost opportunity for participants to better their overall situation.

To help draw attention to better outcome and worse outcome feedback, it may be useful to make these outcomes more salient. Such a manipulation has found success in a study by Nieuwenhuis and colleagues (2004). In their study, pairs of lotteries were presented sequentially, each with two potential outcomes. After an outcome was selected, either the valence of the outcome, gain or loss, or the performance, better or worse outcome, was highlighted. Performance in their study, however, referred to whether or not the choice selected was best in accordance to the outcome (i.e., a risk-seeking choice when the outcome was better). Using ERP technology, Nieuwenhuis and colleagues found that when valence was highlighted, an FRN responded to loss outcomes only, but when performance was highlighted, an FRN was found in response to worse outcomes only.

In the future, it would be valuable to test the effects of luck when it is made more salient, and whether this can affect risk taking. A study similar to the current study could be repeated, but with an increased focus on whether the outcome was better or worse, not performance as define by Nieuwenhuis and colleagues. If the luck manipulation, is made more salient perhaps

participants would recognize the statistical advantage of responding to good luck with risk-seeking behavior and bad luck with risk-averse behavior. Additionally, it would be useful to edit the manipulation so that luck is decoupled from the amount of gains experienced in the study. This would create an environment in which the effects of fortune, luck, and number gains could be isolated, and examined for their potential effects on risk taking.

Conclusion

The current study offers evidence to suggest that people may not overtly distinguish luck from fortune, yet in terms of risk taking, their response to fortune is clearly differentiated from luck. A fortunate context may promote a sense of comfort and security which in turn promotes risk averse behaviors. Conversely, an unfortunate context may create a context which is uneasy, and therefore decision makers chase the best outcomes to better their deteriorating situation. Such behavior would promote a risk-seeking strategy.

However, being in an unfortunate context does not necessarily make a risk-seeking strategy more advantageous, nor does a fortunate context make risk aversion the best strategy. By being risk averse, those in the GF-GL condition missed an opportunity to increase their net earnings and by being risk seeking those in the BF-BL condition lost more net earnings than needed. In a real-world application, this may imply that people sometimes do not take full advantage of a good situation, nor do they do as much as possible to prevent the damaging effects of a bad situation. This latter problem may be a contributor to the "sunk cost" effect (Arkes & Blumer, 1985). Instead of accepting a loss, risk taking is increased in attempts to recover from the poor situation. However, if the better outcome is not more likely, this could worsen the situation. If people better recognized when they were repeatedly experiencing worse

outcomes (i.e., bad luck), it might encourage them to cut their losses when it is likely to be advantageous.

Although feelings of luck and fortune do change in accordance with the luck and fortune manipulations, the overall sense of being lucky and fortunate is more proximally related to the number of gain outcomes experienced in the study. An increasing number of gains is closely associated with increases in subjective good luck and fortune. This finding is largely consistent with predictions based on the somatic marker and hedonic editing hypotheses. Yet, it still is the case that risk taking behavior seems largely disconnected from subjectively experienced luck and fortune. This disconnect between feelings and behavior is exemplified by comparing the BF-GL and BF-BL conditions. Though both had similar ratings of perceived luck and fortune, risk taking differed greatly.

The finding that subjective feelings of luck and fortune do not systematically vary with risk taking seems inconsistent with the growing body of literature which describes emotion and feelings as a central driver of decision making (e.g., Lerner et al., 2015; Slovic et al., 2004; Loewenstein et al., 2001). Generally, it is proposed that emotion can sometimes overpower reasoning in decision making, which, depending on the situation, can be advantageous or disadvantageous. Yet, in the current study, it seems that affect (at least concerning luck and fortune) is not as influential as the positive or negative context within which the decision occurs.

From this study we may conclude that a generally positive situation can promote risk-averse behavior, whereas a generally negative situation can promote risk-seeking behavior. However, this pattern of risk taking may be particular to situations in which the context is consistently good or bad. Neither increases in better outcomes, nor increases in perceptions of good luck and good fortune had a direct effect on risk-taking, although both reflect a good or

improving situation. These subtle, yet important differences in the *way* an event or series of events becomes positive and negative may have implications for how individuals evaluate decisions, and ultimately risk-taking behavior.

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Appendix A

Fortune and Luck Attribution and Identification Measure (FLAIM)

All items will be score on a 5 point Likert type scale with higher scores indicating higher endorsement of the target attitude.

Attribution of Luck

1. Bad luck was with me today.	Good luck was with me today.
2. I was unlucky in my lottery outcomes.	I was lucky in my lottery outcomes.
3. Overall I was unlucky.	Overall I was lucky.
4. I experienced bad luck.	I experienced good luck.

Identification of Luck

1. I felt my odds of getting the better outcome were low.	I felt my odds of getting the better outcome were high.
2. I felt an increased likelihood of getting the worse outcome.	I felt an increased likelihood of getting the better outcome.
3. I got the worse outcome more than I expected.	I got the better outcome more than I expected.
4. The chance of getting the worse outcome was high.	The chance of getting the better outcome was high.

Attribution of Fortune

1. Fortune was against me.	Fortune was in my favor.
2. My lottery outcomes were unfortunate.	My lottery outcomes were fortunate.
3. Overall my performance was unfortunate.	Overall my performance was fortunate.
4. My lotteries were a result of bad fortune.	My lotteries were a result of good fortune.

Identification of Fortune

1. I had more negative lotteries than I expected.	I had more positive lotteries than I expected.
2. The lotteries I received were usually bad.	The lotteries I received were usually good.
3. More often I had to choose between losses.	More often I had to choose between gains.
4. The lotteries I received were unusually negative.	The lotteries I received were unusually positive.