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Contemplating single versus multiple encounters of a risky prospect

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The use of qualitative evaluations and comparisons entailed by heuristic choice strategies may account for the occurrence of decision anomalies such as certainty effects, possibility effects, and preference reversals. The strong reduction of these effects when gambles are represented as being played many times suggests that the multiple-play representation leads to an increase in the use of integration strategies that are more quantitative. This hypothesis was supported by subjects' written justifications for choosing or refusing to play a gamble 1 or 100 times. Justifications for single-play choices tended to focus on single attributes of the gamble, whereas justifications for multiple play choices tended to reflect strategies that integrated probabilities and outcomes.

Traditionally, psychological models of risky decision making have been founded upon the assumption that people employ quantitative reasoning strategies when they consider risky prospects. For example, the many variants of subjective expected utility theory (cf. Schoemaker, 1982) all assume that subjects implicitly do the following: (a) consider outcomes in terms of their corresponding utility values (defined on an interval-level scale); (b) weight these utilities by corresponding probabilities, subjective probabilities, or decision weights; and (c) aggregate these utilities to arrive at an overall value of subjective utility.

One may trace the predilection of decision theorists for this type of aggregated multiplicative model of risky decision making to the normative appeal of Von Neuman and Morgenstern's (1947) theory of expected utility. It seems only natural for early researchers to have begun searching for a descriptive theory of decision behavior by comparing people's decisions with an appealing prescriptive theory. The initial success of this approach (e.g., Davidson, Suppes, & Siegel, 1957) is no doubt responsible for the proliferation of models of sub-

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jective expected utility (SEU), with Kahneman and Tversky's (1979) prospect theory currently the best known of these.

However, at the same time that SEU theories were recording successes, numerous anomalous findings were continually calling into question the descriptive accuracy of the basic framework. These anomalies included work by Allais (1953) on how people integrate outcomes that occur with probabilities at or close to certainty (the Allais paradox); work by Ellsberg (1961) on how people resolve ambiguities about uncertainties (the Ellsberg paradox); work by Lichtenstein and Slovic (1971) on how the ordering of preferences for risky prospects depends on how responses are elicited (the preference reversal phenomenon); and work by Tversky and Kahneman (1981) on how preferences for risky prospects depend on how the information is presented (framing effects).

Over the years, SEU theory has been amended to account for many of these anomalies. Prospect theory (Kahneman & Tversky, 1979) is an excellent example of how the basic aggregated multiplicative model can be modified to incorporate these effects. This is done, in part, by including discontinuities in the decision-weighting function and proposing a cognitive editing phase prior to the quantitative integration of subjective values. Both of these changes represent large steps away from a strictly quantitative approach to modeling decision behavior.

Indeed, there appears to be very little direct evidence that people employ the quantitative operations proposed by SEU theories when considering risky prospects. As a counterpoint to the quantitative approach, Reyna and Brainerd (1991) have proposed a fuzzy-trace theory of decision making, which asserts that people prefer to use more propositional forms of reasoning when considering risky prospects. Their theory argues that people resolve information at the coarsest category level that they feel will produce an acceptable solution. Although people are capable of numerical encoding and quantitative integration, they prefer to use more categorical information and simpler operations. Thus, for example, the description of an alternative ***A***, "20% chance to win $5.00, else win $0.00," may be coded as "some chance to win something and some chance to win nothing." Of course, this level of encoding may be too coarse for some tasks or choice sets, but it may help reduce conflict and facilitate choice in other settings. For example, when comparing alternative ***A*** to alternative ***B***, "15% chance to win $10, else lose $1.00," (coded "some chance to win something and some chance to lose something"), the coarse coding facilitates decision making by creating a dominance relation of ***A*** over ***B***.

The tenets of fuzzy trace theory are also consistent with the cost benefit framework of the adaptive decision maker described by Payne, Bettman, and Johnson (1988). Their research provides evidence that the aggregating and multiplicative operations implied by SEU theory require much more cognitive effort and are oftentimes not much more accurate than coarser heuristic strategies that require little effort. Given the mounting evidence that people regularly use nonquantitative heuristic strategies (Payne, Bettman, & Johnson, 1992), one may argue that many decision anomalies simply reflect a tendency of subjects to apply heuristic or propositional strategies in risky decision making rather than the aggregated multiplicative operations described by various SEU theories. From this perspective, conditions that lead to the reduction or elimination of decision anomalies may do so through promoting more quantitative strategies, such as summing the products of utilities and probabilities.

The research we present in this article examines this prediction with respect to the manipulation of the number of times a risky prospect is to be played, a manipulation which has been demonstrated to reduce anomalous decision behavior. Before proceeding to experimental detail, we will first briefly review the literature on single versus multiple plays of a prospect. We then describe how we would expect subjects' decision strategies to differ when considering single versus multiple plays of a gamble, and how these differences might be reflected in retrospective justifications of their decisions.

The multiple-play framework

In an early thought-provoking article, Samuelson (1963) presented an analysis of the risk involved in single and multiple encounters of a risky prospect. His analysis centered on an example of a colleague who refused to risk $100 for a 50/50 chance to win $200, but who then stipulated that he would be willing to place the bet if he were guaranteed 100 such opportunities. Samuelson and others (Samuelson, 1963; Tversky & Bar-Hillel, 1983) have pointed out conditions under which such behavior would violate expected utility theory and other normative theories of decision making. In many respects, Samuelson's complaint with his colleague's behavior focused less on his willingness to accept the 100 plays of the bet than on his unwillingness at the same time to accept a single play of the bet. This inconsistency between choices suggested that the colleague was not applying the same decision rule to single and multiple plays of the bet.

Picking up on Samuelson's example, Lopes (1981) has questioned the applicability of expected utility theory to short-run or "one shot" events. From a normative perspective, she argued that expected utility theory fails to capture aspects of the outcome distribution that may have important consequences for real-world decisions (see also Allais, 1979). These characteristics include the median, mode, variance, and skewness of the distribution. Differences between prospects, and inconsistencies within prospects, on these distributional characteristics tend to lessen with an increase in the number of times a prospect is instantiated, due to principles of asymptotic statistics (e.g., the central limit theorem asserts that sampling distributions of means become more normal and thereby differences among the mean, median, and mode decrease).

From a psychological perspective, Lopes argued that the concept of expected value or utility may appear to have little relevance to people when a gamble is only played once. In such cases, the expectation will virtually never correspond to an actual outcome that results from playing the gamble once. For example, the expected value of the prospect, "50% chance to win $10, else win nothing," is $5.00; however, the only outcomes that can be realized on a single play are $0.00 and $10.00. Only as the number of plays increases will the expected value begin to correspond to values that are representative of those that result from actually playing the gamble the given number of times. For example, the expected value of 10 plays of the above prospect is $50.00, which corresponds to the modal outcome. Given this greater correspondence between expected and actual outcomes under multiple play conditions, people may find the quantitative integration implied by SEU theories more applicable. Research by Montgomery and Adelbratt (1982) has provided some evidence in support of this assertion. Their subjects stated that they were unwilling to accept the use of the principle of expected value to guide their choices for single plays of a gamble, but most did state a willingness to accept the principle as a basis for choice when the gamble would be played 10 or more times.

If people are more willing to accept the quantitative expectation rule of SEU theories as the number of instantiations increases, then decision anomalies should be reduced when prospects are represented as being instantiated many times. This prediction has received empirical support with regard to two decision anomalies. The Allais paradox[1] virtually disappears when subjects choose between 100 plays of each gamble rather than between a single play of each gamble (Keren, 1991; Keren & Wagenaar, 1987). Response-mode-induced preference reversals[2] are also virtually eliminated when subjects evaluate 100 plays rather than 1 play of each bet (Wedell & Böckenholt, 1990, 1992). Thus, a general conclusion one can draw from these studies is that people's evaluations of risky prospects are more consistent with normative theories, such as expected utility theory, when the same prospects are presented as being encountered many times (e.g., 100 plays of the same gamble).

Retrospective justifications of decisions involving single versus multiple plays

The general hypothesis we investigated was that people tend to use choice strategies that integrate probabilities and outcomes in a way that is more consistent with SEU theories when a gamble is represented as being played many times rather than just once. To explore this hypothesis, we presented subjects with a modified form of the gamble contemplated by Samuelson's colleague. Subjects indicated whether they would be willing to play the gamble once, and then whether they would be willing to play it 100 times. Immediately after each choice, subjects provided written justifications of their decisions (see Ericsson & Simon, 1980, for a discussion of potential problems with retrospective verbal protocols).

We analyzed these retrospective protocols predominantly from an exploratory perspective to document regularities in their responses and to speculate on how subject and situational variables may moderate the effects of manipulating the number of plays. However, the distinctions between qualitative and quantitative strategies discussed above provided us with a framework for generating a classification scheme and relating these classifications to our general hypothesis.

Justifications for single-play gambles. Figure 1 presents a decision tree illustrating different strategies a person might use to determine whether to accept or refuse a single play of a gamble. This delineation of strategies is not meant to be complete, but rather it attempts to provide some flavor of a hierarchy of strategies differing in levels of complexity. The further down a branch extends, the greater the complexity of (and cognitive effort required by) the strategies. We also assume that differences in retrospective justifications of choices can be related to differences in choice strategies.

The strategy requiring the least effort is to adopt the policy of refusing to play any gamble. One may adopt such a policy on moral grounds or simply as a general attitude toward investment. In this case, the gamble may be coded as "some chance to lose," which is dominated by the status quo, coded as "no chance to lose." Justifications such as "I never gamble," or "Gambling is stupid," might reflect a reliance on this strategy.

If one is willing to consider playing a gamble, the simplest level of complexity is to focus on one aspect of the gamble. For example, one may focus on whether the potential loss is acceptable, regardless of

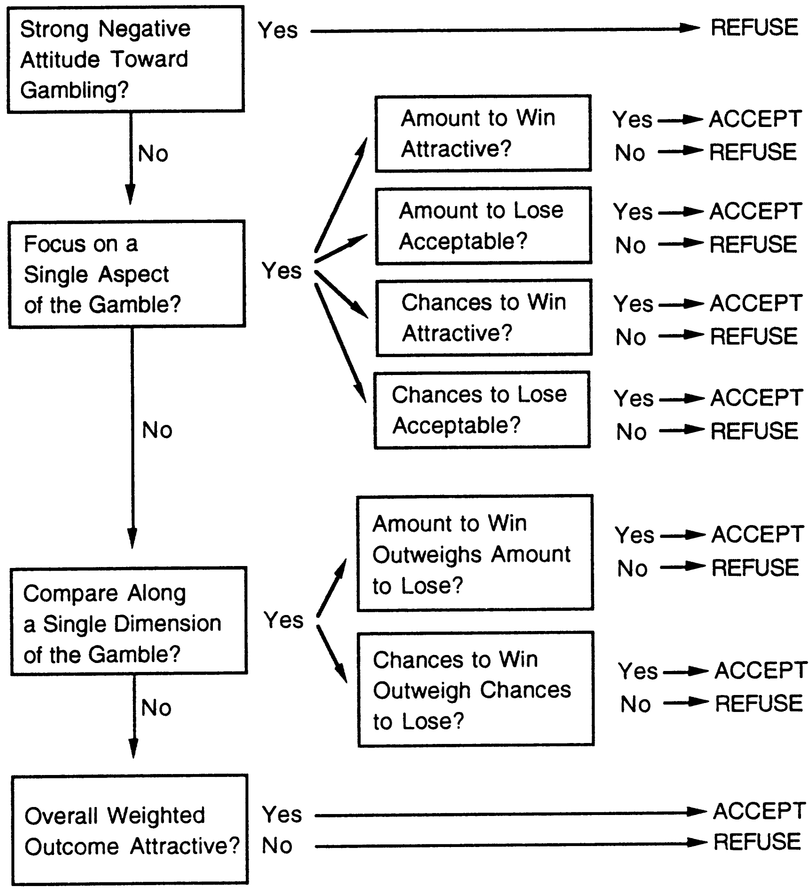

Figure 1. Strategies for determining whether to refuse or accept a single play of a gamble

the amount to win or the probabilities of winning or losing. Thus, if the prospect of losing $50.00 is unacceptable, the gamble might be coded as "some chance to lose an unacceptable amount," which is dominated by the status quo. A justification for refusing the bet because "I can't afford to lose that much" suggests a focus on the unacceptability of the losing outcome. Similarly, a focus on the probability of losing is likely to provide the basis for refusing the bet, coded as "an unacceptable chance to lose something," which is dominated by the status quo. Although a focus on amount or probability to lose is likely to provide a justification of refusing to play the gamble, one could choose to accept the gamble simply because the potential loss or probability of losing is acceptable.

At this level of complexity, justifications for accepting a single play of the gamble are likely to focus on either the amount to win or the chances of winning. For example, coding the gamble as either "an attractive probability to win something" or as "some chance to win something attractive" results in the gamble dominating the status quo. Justifications such as "I have a good chance to win," or "I could use the $100," would then reflect an emphasis on this type of strategy.

At the next level of complexity, one might compare probabilities or dollar amounts, but fail to fully integrate the two types of information. Thus, for example, regardless of the chances of winning or losing, one might argue that the amount to win is not worth risking the amount to lose. Similarly one might compare the chances of winning with the chances of losing without regard for how much is won or lost. For two-outcome bets, this last strategy is difficult to distinguish from simply concentrating on the probability to win or the probability to lose because the probabilities are complementary.

Finally, the highest level of complexity depicted consists of considering the various probabilities and amounts to win or lose in an integrated fashion. SEU strategies would represent examples of this type of reasoning, although a weighted sum is not the only operation that would qualify. Our general hypothesis suggests that justifications for accepting or refusing the single play of the gamble will predominantly fall at the lowest levels of complexity and rarely include integrated strategies such as the weighted sum strategy.

Justifications for multiple plays. The set of strategies described in Figure 1 for single plays of a gamble is equally applicable to multiple plays of a gamble. Our general hypothesis implies, however, that subjects will be more willing to use higher level strategies that integrate information about amounts and probabilities to win and lose. This change in strategy should lead a substantial number of subjects to behave like Samuelson's colleague, refusing a single play of the gamble but accepting multiple plays. Figure 2 presents a flow diagram that describes conditions that would lead subjects who refused a single play of the gamble to either refuse or accept multiple plays of the gamble.

Given that one has refused a single play of the bet, a logically necessary condition for accepting multiple plays of that gamble is that the subject recognizes a change in the outcome distribution. Subjects who process multiple plays of a gamble essentially as the "same" as a single play should likewise refuse multiple plays of the gamble. Those who refuse to play the bet because of a strong negative attitude toward gambling might be most likely to fall into this category. For example, if they process a single play as "some chance to lose something," which

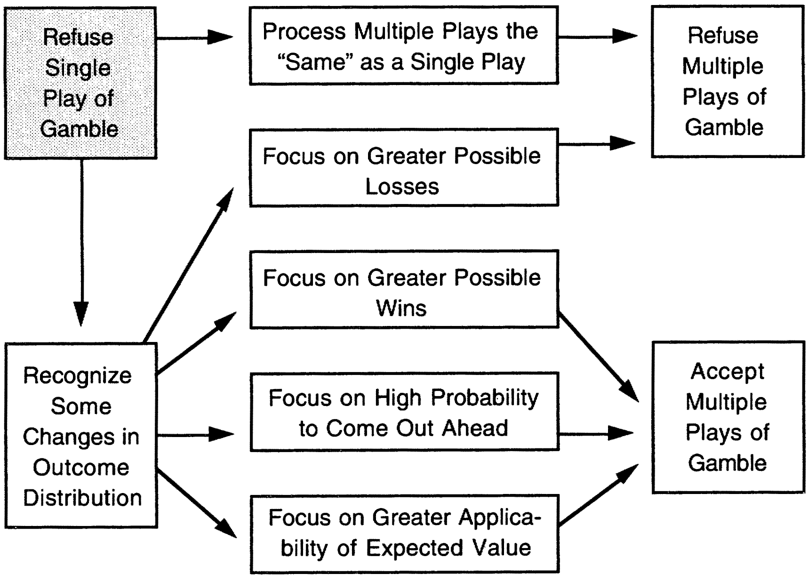

Figure 2. Model of strategies that would lead subjects who refused a single play of the gamble to refuse or accept multiple plays of the gamble

is dominated by the status quo, then multiple plays of "some chance to lose something" should seem equally unacceptable.

The recognition of a change in the distribution of outcomes, however, is not sufficient for a change in one's decision. What is crucial is how the subject perceives the distribution has changed and which features of the changed distribution the subject considers. For example, one way in which playing Samuelson's bet 100 times changes the distribution of outcomes is that the maximum potential loss increases from $100 to $10,000. Thus, a subject who focuses exclusively on the amount to lose may refuse 100 plays of the gamble because of its greater potential loss. On the other hand, a subject who focuses only on the potential amount to win may now choose the 100 plays because one can win $20,000 instead of just $200.

One important way in which the outcome distribution may be perceived to change when a gamble is played many times is in terms of how the probabilities to win and to lose match up with actual proportions of wins and losses. When a gamble is played only once, the observed proportion for any outcome will be either 0 or 1, regardless of its probability. When a gamble is played many times, the observed proportion for each outcome should be close to its probability. The perception of a better match between probabilities and outcome proportions with more plays may then lead subjects to view the quantitatively precise information described in the probabilities as directly applicable to their decisions. This suggests that subjects may be more willing to use quantitative integration strategies when considering gambles that will be played many times.

One integrative strategy for subjects to consider then is the application of the expectation principle implied by SEU theories. The perception of the greater applicability of the expectation principle should lead subjects to choose 100 plays of Samuelson's bet, which has a high expected value.

An alternative integrative strategy subjects might use is to determine the probability of coming out ahead (i.e., beating the status quo). For the single-play situation, this simply corresponds to the probability of a win and thus does not require integration of probabilities and amounts (e.g., the probability of coming out ahead for one play of Samuelson's bet is .50, the probability of winning). But for multiple plays, one needs to consider both probabilities and outcomes to determine the chances of winning. Thus, for example, a person might reason that with Samuelson's bet, one can lose twice for every win and still break even. This means that one can lose two-thirds of the plays and break even. One may then choose to play if the probability of winning 33 times out of 100 plays seems sufficiently high given a probability to win of .5 on each trial. With Samuelson's bet, the probability of coming out ahead is better than 999 to 1.[3] Although subjects may not know how to calculate these odds, they may well have an intuitive feel for them and thereby choose to play the gamble 100 times, even though they refused a single play.

EXPERIMENT

METHOD

Subjects and design

Subjects were 161 students from the University of South Carolina who participated in partial fulfillment of psychology course requirements (19 were graduate students in psychology or business departments, the rest were undergraduates). The only manipulated variable was number of times (1 or 100) that a hypothetical bet would be played, with the single-play situation always encountered first. Dependent variables consisted of subjects' decisions to play the hypothetical bet (*yes* or *no*) and written reasons for their decisions.

Stimuli and procedures

Subjects were given the following instructions:

Consider the following gamble: "You wager $50 on a coin flip (50/50 chance)

to win $100." Thus, if the coin comes up "heads," you win $100, but if it comes up "tails," you lose your $50. If you had the chance to play this gamble, would you?
___ (yes or no).
Explain why or why not.

After responding *yes* or *no*, subjects provided written explanations of their decisions in the designated area on the page. They then turned the page of the booklet and were presented with the following instructions:

Now consider that you are offered 100 plays of this same gamble. That is, you can work through 100 coin tosses and for each of them: "You wager $50 on a coin flip (50/50 chance) to win $100." Thus, *on each of 100 coin tosses*, if the coin comes up "heads," you win $100, but if it comes up "tails," you lose your $50. If you had the chance to play this gamble 100 times, would you?
___ (yes or no).
Explain why or why not.

RESULTS AND DISCUSSION

Choice proportions

Table 1 presents the different choice patterns exhibited by subjects. Undergraduate and graduate students exhibited similar choice patterns and so are combined here. Although most subjects refused a single play of the bet, about half were willing to play the bet 100 times. This difference was significant by McNemar's symmetry test for matched pairs, $\chi^2(1) = 36.0$, $p < .001$. Although the behavior pattern of Samuelson's colleague was not the modal pattern in this sample, it was exhibited by a substantial percentage (34%) of the subjects.

Analysis of written justifications

Classification scheme. Our analysis of the written justifications for each decision was guided by a primary interest in distinguishing those who refused both 1 and 100 plays of the bet from those who refused 1 play but accepted 100 plays. We first developed a classification scheme for the single-play condition, and augmented this scheme for the 100-play condition. The classification scheme was based on the distinctions presented in Figure 1 and is shown in Table 2. Five major categories were developed to conceptually distinguish among subjects' justifications of their choices. The lettered statements listed below each category represent the gist of specific (and separable) rationales. A sixth category was created for responses that implied that the subject was confused about or misconstrued the gamble (about 8% of the statements).

Table 1. Frequencies and percentages of subjects accepting the gamble as a function of number of times it is played

	Play 1 time?		
Play 100 times?	No	Yes	Total
No	71 (44.1%)	8 (5.0%)	79 (49.1%)
Yes	56 (34.8%)	26 (16.1%)	82 (50.9%)
Total	127 (78.9%)	34 (21.1%)	161 (100.0%)

Category 1 justifications made reference to a philosophical attitude toward gambling and corresponded to the coarsest level of encoding described in Figure 1. Justifications classified into this category consisted of either a policy statement for or against gambling, or a world view of being either lucky or unlucky.

Category 2 justifications focused on a single outcome value and corresponded to the second coarsest level of encoding we have described. These justifications consisted of arguments that the potential loss was too great to risk or the gain was particularly attractive.

Category 3 justifications focused on odds or probability to win or lose and corresponded to either the second or third coarsest level of encoding described in Figure 1. For two-outcome gambles, the probabilities for the different outcomes are complementary, so that justification in terms of "chances of losing are too high" may indicate a focus on a single aspect (i.e., probability of the loss) or a comparison along a single dimension (i.e., comparing probabilities of winning or losing). Subjects often used the term "odds," which would imply a comparison of probabilities. Justifications classified into Category 3 described odds of winning or losing without mentioning outcome amounts.

Category 4 justifications compared values of wins and losses and corresponded to the third coarsest level of encoding described in Figure 1. These justifications overtly compared the amounts to win and lose without mentioning relative probabilities.

Category 5 justifications implied an integration of probabilities and outcomes and corresponded to the most complex level of reasoning described in Figure 1. These descriptions either overtly mentioned weighing the outcomes and probabilities or implied such a weighing process.

Table 2. Categories used to classify retrospective justifications

Type of explanation
1. Philosophical attitude toward gambling
a. Do not like to gamble/gambling is stupid
b. Like to gamble
c. I am unlucky/I usually lose (at coin flips)
d. I am lucky/I often win (at coin flips)
2. Focus on a single outcome
a. Cannot afford or dislike the risk of losing $50
b. Cannot afford or dislike the risk of losing $50 several times
c. Can afford to lose $50/it's only $50
d. Can win $100/chance to double my money
e. Can win $100 several times/could get rich
3. Focus on odds or probability
a. Odds are not favorable enough/likely to lose
b. Odds are good/unlikely to lose
c. Would come up heads (a win) about 50% of the time
4. Weighing or comparing values of wins and losses
a. Possible loss ($50) outweighs possible gain ($100)
b. Possible gain ($100) outweighs possible loss ($50)
5. Integration of probabilities and outcomes
a. Expectation is to break even or lose
b. Would need fewer than one-third heads to come out a loser
c. Expectation to come out ahead/high expected value
d. The chances of winning or coming out ahead are high/better chances to come out ahead
e. Can lose twice for each win
f. Too much to risk at these odds
g. Risk worthwhile at these odds

Responses were categorized by the first author and two research assistants, with any inconsistencies being resolved by discussion with the second author. Although subjects could provide multiple reasons for their behavior, the vast majority provided a single reason (about one-fourth of the subjects provided two or more reasons). For statistical analyses, subjects were classified according to the justification for each choice that corresponded to the highest category level. Justifications could not be classified into any of the five categories for 8 subjects under the single-play condition and 10 subjects under the 100-play condition. These unclassified justifications were excluded from the analyses described below.

Justifications for accepting or refusing a single play. Table 3 presents a classification of the reasons given for accepting or refusing a single play of the bet as a function of response pattern to the single- and 100-play gambles. There were four possible response patterns: ***no*** to both 1- and 100-play bets (*NN*); ***yes*** to both bets (*YY*); ***no*** to 1-play but ***yes*** to 100-play bets (*NY*); and vice versa (*YN*).

We first focus on the degree to which the level of reasoning predicts choices in the single-play situation (i.e., combining response patterns *NN* with *NY*, and *YN* with *YY*). The chi-square test was significant, $\chi^2(4) = 14.7$, $p < .01$, and represented a moderate tendency for low-level justifications to correspond to refusing to accept the single-play bet (Cramer's $\phi = .31$). Although only 8% of those classified into the bottom two categories accepted the single-play bet, 29% of those classified into the upper three categories accepted it. This pattern is consistent with a two-stage choice process (Wedell & Böckenholt, 1990) in which one first evaluates the acceptability of the prospect in terms of satisfying a minimum level of security (aspiration-level) and goes on to a more integrative analysis only if those security needs are met. The general tendency to refuse to play the gamble by those whose justifications implied an integration strategy (i.e., Category 5) is consistent with the negatively accelerated utility functions assumed by most SEU theories.

Another way to look at the data in Table 3 is in terms of whether those who show the *NN* pattern differ from those who show the *NY* pattern in terms of how they justify their refusal to play the gamble one time. Excluding the *YY* and *YN* subjects, there was a moderate relationship between category level and response pattern, $\chi^2(4) = 10.1$, $p < .05$ (Cramer's $\phi = .29$). Only 35% of those whose justification for refusing a single play fell into the lowest two categories went on to accept 100 plays of the gamble, whereas 56% of those whose justification for refusing a single play fell into the upper three categories went on to accept 100 plays of the gamble.

Justifications for accepting or rejecting 100 plays. Table 4 presents a classification of the reasons given for accepting or refusing 100 plays of the bet as a function of subjects' response patterns. In comparison with Table 3, the most striking feature of the data is the strong shift toward higher level justifications. The tendency is greatest for those who accept the 100-play bet (i.e., *NY* and *YY* subjects).

Once again, we can assess the degree to which the level of reasoning predicts choices (i.e., combining response patterns *NN* with *YN*, and *NY* with *YY*). Because no justifications fell into Category 4, this category was not included in the following analyses. The chi-square test was significant, $\chi^2(3) = 55.6$, $p < .001$, and represented an even stronger

Table 3. Frequencies of different justifications for single-play choices as a function of response pattern

Justification category	Response pattern				
	NN	*NY*	*YN*	*YY*	Total
1	14	7	0	2	23
2	31	17	2	2	52
3	9	12	3	7	31
4	1	7	2	4	14
5	14	12	0	7	33
Total	69	55	7	22	153

Note: *NN, no* to both 1- and 100-play bets; *NY, no* to 1-play but *yes* to 100-play bets; *YN, yes* to 1-play but *no* to 100-play bets; *YY, yes* to both 1-play and 100-play bets.

tendency for high level justifications to correspond to accepting the bet (Cramer's ϕ = .61). Only 11% of those classified into Categories 1 or 2 accepted 100 plays of the bet, whereas 70% of those classified into Categories 3–5 accepted 100 plays of the bet. The distinction between the justifications given by *NN* and *NY* subjects was also much more pronounced than in the single-play condition, as revealed by the much stronger association, Cramer's $\phi = .66$, $\chi^2 = 53.1$, $p < .001$.

Changes in justifications from 1 to 100 plays. Tables 3 and 4 present data for 1 and 100 plays separately. Table 5 combines these data in a 4 × 5 × 5 (Response Pattern × Single-Play Justification × 100-Play Justification) transition table. A log linear analysis was conducted to find a model that best characterizes the data (with .5 added to the frequencies of each cell). The independence model (i.e., main effects model) was rejected ($p < .001$). A parsimonious way to summarize the data of Table 5 is to consider the data for *NN* subjects separately from those for *NY, YN,* and *YY*. For the *NN* subjects, most of the responses fall on the diagonal cells, $\chi^2(16) = 68.0$, $p < .001$, indicating strong consistency in justifications for 1 and 100 plays. However, the test for independence (fitting only main effects) for *NY, YN,* and *YY* subjects was nonsignificant, $\chi^2(64) = 57.6$, $p > .40$. Thus, for this latter group, knowing the subject's justification for accepting or refusing a single-play bet did not aid in predicting that subject's justification for accepting or refusing 100 plays of the bet. For the *NY* subjects, 100-play justifications appear to operate almost exclusively at Category 5, integration of probabilities and outcomes. For *YN* subjects, 100-play justifications are focused on a single outcome, the negative consequences of losing 100 times, and hence they refuse

Table 4. Frequencies of different justifications for 100-play choices as a function of response pattern

Justification category	Response pattern				
	NN	*NY*	*YN*	*YY*	Total
1	13	0	0	0	13
2	24	0	6	5	35
3	13	5	0	4	22
4	0	0	0	0	0
5	18	49	0	14	81
Total	68	54	6	23	151

*Note. NN, **no*** to both 1- and 100-play bets; *NY, **no*** to 1-play but ***yes*** to 100-play bets; *YN, **yes*** to 1-play but ***no*** to 100-play bets; *YY, **yes*** to both 1-play and 100-play bets.

to play. For *YY* subjects, 100-play justifications are either at Category 3 or 5.

Strategies for considering single- and multiple-play choices

The classification scheme of Figure 1 provided a useful framework for categorizing subjects' retrospective justifications of the choices. One may, of course, argue that these justifications do not bear directly on strategies invoked by subjects, but are more determined by communicational norms and constraints. From this perspective, one might interpret the results as evidence that communication of simplistic justifications based on a single attribute is deemed appropriate for single-play situations but that communication of more complex justifications that integrate outcomes and probabilities is deemed more appropriate for multiple-play situations.

However, if one adopts a fundamental tenet of fuzzy-trace theory that decision makers operate on the verbal gist that they abstract from the decision problem (Reyna & Brainerd, 1991), then what the subject decides to communicate through retrospective justifications may be particularly relevant to the gist on which he or she is operating. The empirical validation of these retrospective justifications as veridically representing choice strategies requires many converging lines of evidence from online process-tracing methods. However, if one is willing to assume that the rationales given by subjects reflect some important differences in their choice strategies, then the observed pattern of results provides support for our general hypothesis that subjects tend to use low-level coarse categorization strategies for considering single

Table 5. Frequencies of different justifications for single- and 100-play choices as a function of response pattern

Pattern/ justification for single play	Justification for 100 plays				
	1	2	3	4	5
NN					
1	10	2	0	0	0
2	3	18	4	0	5
3	0	1	8	0	0
4	0	0	1	0	0
5	0	2	0	0	12
NY					
1	0	0	0	0	6
2	0	0	3	0	14
3	0	0	1	0	11
4	0	0	1	0	6
5	0	0	0	0	12
YN					
1	0	0	0	0	0
2	0	1	0	0	0
3	0	3	0	0	0
4	0	2	0	0	0
5	0	0	0	0	0
YY					
1	0	0	0	0	2
2	0	2	0	0	0
3	0	1	4	0	2
4	0	1	0	0	3
5	0	1	0	0	5

Note. Underline indicates modal response for a row. *NN*, ***no*** to both 1- and 100-play bets; *NY*, ***no*** to 1-play but ***yes*** to 100-play bets; *YN*, ***yes*** to 1-play but ***no*** to 100-play bets; *YY*, ***yes*** to both 1-play and 100-play bets.

plays and more integrative and quantitative strategies for considering multiple plays of a gamble.

Individual differences in considering multiple plays

The characterization of the general tendency of subjects given above is somewhat misleading, because what is most striking from the data are the large individual differences in how subjects considered single- and 100-play situations. Our framework (presented in Figure 2) for determining conditions under which subjects who refuse a single play might accept or reject multiple plays of the same gamble proved useful in explaining these differences. Those subjects who refused both single and multiple plays (*NN*) tended to (a) overtly assert the same rationale, (b) consider the low-level strategy of philosophically rejecting gambling, and (c) focus on the potential losses involved. On the other hand, those subjects who like Samuelson's colleague refused a single play but endorsed multiple plays (*NY*) tended to (a) focus on the greater chances to come out ahead and (b) overtly consider an expectation principle. The modal explanation for *NY* subjects that "the chances of coming out ahead are high" is consistent with the idea that decision makers often consider the choice with reference to an aspiration level, which is often the status quo (cf. Payne, Laughhunn, & Crum, 1980). In the single-play situation, the chances of exceeding the aspiration level can be determined through simply considering the probability of winning. In the multiple-play situation, this assessment requires integration of outcomes and probabilities and therefore should lead to behavior that is more consistent with that prescribed by expected utility theory. Furthermore, although only a small number of *NY* subjects actually made direct reference to the expected value of the bet (calculating out what they felt they would win, $2,500), no one in the single-play condition used calculations of expected value to justify his or her choice.

Although relatively few subjects exhibited the *YN* or *YY* patterns, our reasoning-based framework provides some insights into distinguishing between these subjects. What most differentiates *YY* subjects from *YN* subjects is that the former, like the *NY* subjects, justify their responses to the 100-play condition in terms that imply an integration of outcomes and probabilities. Consider the person who accepts a single play because "I can afford to risk $50," a Category 2 justification. A person who maintains this level of justification is likely to reject 100 plays because "I can't afford to lose $50 that many times." All of the *YN* subjects fell into this category.

In conclusion, we believe a reasoning-based framework for understanding how subjects choose between risky prospects may help to further illuminate the choice process. In addition to the fuzzy-trace framework offered by Reyna and Brainerd (1991), other researchers have begun to argue for the importance of reasoning strategies in judgment and choice (Johnson-Laird, 1992; Pennington & Hastie, 1988; Simonson, 1989; Shafir & Tversky, 1992). The research presented here documents the usefulness of a reason-based approach in distinguishing among choices made for single and multiple instantiations of prospects as well as predicting individual differences in choice patterns. The retrospective justifications were predictive in the sense that they significantly discriminated between subjects who accepted or refused to play the bet in 1- and 100-play conditions, and also described what types of changes in justifications were associated with the pattern of choice described by Samuelson's colleague. From a broader perspective, the distinction between single and multiple plays may parallel the distinction between frequentistic and single-case modes of reasoning about probabilities (Gigerenzer, 1991). In this regard, quantitative integration strategies may appear more applicable to decision makers when considering an aggregate set of events (the frequentistic representation) than when considering a single, unique case.

Notes

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1. As first described by Allais (1953), this paradox consists of the willingness of most people to choose an alternative A = ($1M, 1.0), which stipulates winning $1 million with certainty, over alternative B = ($2.5M, .10, $1.0M, .89, $0, .01), while at the same time preferring alternative B' = ($2.5M, .10, $0, .90) over A' = ($1M, .11, $0, .89). According to expected utility theory, the choice of A entails the choice of A', but this violates most people's intuitions—hence the paradox.
2. Response-mode-induced preference reversals typically take the form that people tend to choose a prospect with a high probability to win a moderate amount of money (e.g., $4, .89, $0, .11) over one with a low probability to win a large amount of money (e.g., $40, .11, $0, .89), while at the same time they assign greater monetary worth to the latter prospect. Thus, preferences derived from choice and pricing procedures do not agree.
3. For Samuelson's example, this is a binomial problem which may be solved using the normal approximation to the binomial distribution. The standard error of the sampling distribution is given by $[(p)(1 - p)/n)]^{1/2}$, which is .05 in our example. Thus, winning 34 times out of 100 corresponds to a $Z = (0.34 - 0.50)/.05 = -3.2, p < .001$.

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