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An Examination of Underlying Causes for Differences in Affect-Rich and Affect-Poor Choice

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Table of Contents

List of Tables

List of Figures

Abstract

Real life decision-making frequently involves some level of affect, and research has demonstrated that individuals decide differently when outcomes are more or less rich with feeling. This difference in choice has previously been attributed to probability insensitivity in the presence of affect. In a series of three studies, we explored this possibility, while also testing alternative explanations, namely, that differences exist because of outcome characteristics such as comparability or precision. Individuals made choices between affect-rich side effects and affect-poor monetary lotteries in either a strictly numeric format, or with the addition of an icon array. Across the three studies we found little evidence that the icon array was beneficial, casting doubt on the previous explanation that differences in affect-rich and affect-poor choice are due to probability insensitivity. Contrary to our predictions, we did not find evidence that differences in choice could be attributed to outcome comparability, as there continued to be decrements in affect-rich choice, despite making affect-rich outcomes more comparable. As predicted, when precision in each affective context was better equated by describing monetary outcomes in less precise terms, the difference in affect-rich and affect-poor choice disappeared. It appears that it is difficult to choose well when outcomes are vague, which we suggest is potentially the result of a challenge integrating probability and outcome information. This research is a first step in providing a viable explanation for the "affect gap" and contributes to our understanding of how and why affect-rich and affect-poor choice may differ.

An Examination of Underlying Causes for Differences in Affect-rich and Affect-poor Choice

Each day individuals make countless decisions and, in a majority of cases, these decisions involve some level of affect. Affect can be described most simply as good or bad feeling states that are experienced when encountering various stimuli and situations. For many years, emotional components like affect were disregarded when theorizing about how individuals make choices. However, evidence has shown that affect is not only a component of the decisions we make, but fundamental to our choices.

Throughout life we must frequently make choices between options that involve both affect and some level of risk. For example, we may need to decide which route to take to work in hopes of avoiding a potential traffic jam and the feelings associated with being late. Nevertheless, some decisions involve more affect than others. Making some financial decisions involving risk, such as those about monetary investments, may be less affect-rich. Moreover, these kinds of decisions tend to be based on more quantitative strategies that incorporate estimates of likelihoods and various possible monetary outcomes. In contrast, many affect-rich decisions involve outcomes that are more vivid and less easily quantified; for example, medication side effects. In these cases, quantitative strategies seem less applicable. As a result, qualitative aspects of outcomes may become more central to the decisions, and likelihoods may tend to be neglected.

The present research explores potential causes for differences in processing risky choices when outcomes are more and less rich with affect. We assessed whether these differences in risky choice are likely to result from differences in attention to likelihoods, or differences in the nature and precision of affect-rich qualitative outcomes versus affect-poor quantitative outcomes.

To do this, we will build off recent work by Pachur and colleagues (Pachur & Galesic, 2012; Pachur, Hertwig, & Wolkewitz, 2014; Suter, Pachur, & Hertwig, 2015), who argue that there is an "affect gap," wherein differences in choice between affect-rich and affect-poor outcomes are attributed to affect. They produced evidence that less attention is typically paid to likelihoods in the presence of affect-rich than affect-poor outcomes, causing decisions to be of lower quality in the presence of affect. We provided a critical test of this conclusion, and explored the possibility that the differences in choice may be more closely tied to fundamental differences in the nature of the outcomes assessed in the affect-rich and affect-poor contexts. If affect tends to impede attention to likelihoods, then increasing the salience of and ease of processing probability information should improve affect-rich decisions, increasing the similarity between affect-rich and affect-poor choices.

Alternatively, or in addition, it may be that affect-rich outcomes such as medical side effects are simply harder to compare to one another (e.g., fever versus memory loss) than affect-poor monetary amounts (e.g., $15 versus $30). Unlike monetary outcomes, side effects do not necessarily share the same attributes. Side effects may also be fundamentally more vague, or less precise, than monetary amounts. We tested whether either or both of these are likely to contribute to differences in risky choice across affect-rich and affect-poor contexts. In this way, we explored whether the affect gap was likely to exist because different psychological processes are required to process qualitative versus quantitative outcomes.

The Role of Affect in Choice

Over the last 40 years there has been an outpouring of research dedicated to understanding the role of affect and emotion in decision making (Bechara & Damasio, 2005; Finucane, Alhakami, Slovic, & Johnson, 2000; Loewenstein & Lerner, 2003). Though affect is present in most decisions we make, there is debate about whether and when it is helpful or a hindrance (Loewenstein & Lerner, 2003). For example, affect may be helpful when we use it to inform our choices with information about how we expect to feel in the future with a given outcome. However, it can become a hindrance when feelings not related to the decision (e.g., an underlying mood state) influence our choice behavior.

The introduction of the somatic marker hypothesis by Damasio (1994) provided a pivotal demonstration that affect was not only important in guiding choice, it was also *necessary* for individuals to make choices advantageously. The somatic marker hypothesis is a neurobiological approach to choice positing that interactions with stimuli produce visceral "markers," which are brain and/or bodily states that signify the feeling state produced by the stimuli. These visceral reactions are hypothesized to be utilized either consciously or unconsciously in judgment and choice to help guide individuals in making advantageous decisions, steering them away from decisions that may be disadvantageous (Bechara & Damasio, 2005).

The research on the somatic marker hypothesis highlights the importance of visceral reactions and affective responses in guiding choice advantageously. Utilizing a card task in which there is varied reward and punishment, Bechara and Damasio (2005) found that individuals learned to avoid selecting cards from decks that were disadvantageous in the long run, and hypothesized this was done through utilizing the somatic markers (visceral feelings) to guide their decision behavior. In individuals with brain damage to areas responsible for generating or integrating information related to visceral feelings, there were more disadvantageous choices with many patients failing to recognize which decks were likely to lead to losses. This disadvantageous decision making was also reflected in real world decision making deficits, for example, incurring financial losses, and losses in social standing and friendships. Evidence from research supporting the somatic marker hypothesis is one step towards providing an understanding of the potentially beneficial role of affective components in descriptive choice behavior.

Whereas the somatic marker hypothesis has been pivotal for recognizing the beneficial role that affect can play in decision making, affective contributors can also lead to behaviors that might not be exhibited when affect is not present. One example can be found in the relationship between immediate emotions about events and thoughts about future events (Loewenstein, 1996). Immediate emotions can be influenced by things such as vividness, which leads to an intensification of these emotions, and in turn impacts decision behavior. If vividness does not provide a cue to more beneficial choices, it can harm the quality of decision making. As an example, Loewenstein (1996) points to research on purchases of earthquake insurance. Research has found that purchases for the insurance rise directly after earthquakes, when the objective probability of another earthquake is likely at a low point, but when the emotional reactions associated with the outcome of another earthquake are at a peak (Palm, Hodgson, Blanchard, & Lyons, 1990, as cited in Loewenstein, 1996). This is one example in which an increase in affect can dominate decision making and lead to behaviors that may not otherwise be exhibited in the absence of strong affective feelings.

Attention to probability in affect-rich and affect-poor contexts

Pachur and colleagues (Pachur & Galesic, 2012; Pachur, Hertwig, & Wolkewitz, 2014; Suter, Pachur, & Hertwig, 2016) have conducted several studies exploring decision behavior in affect-rich and affect-poor contexts. The authors have been interested in understanding potential systematic differences in choices and underlying decision strategies in these contexts. They were motivated by work from Rottenstreich and Hsee (2001), who demonstrated probability insensitivity and differences in preferences when outcomes were affect-rich versus affect-poor. Rottenstreich and Hsee (2001) found that at a low probability (1% likelihood), individuals would pay more to avoid an affect-rich outcome (electric shock) than a similarly-valued affect-poor outcome (monetary loss); however, at a high probability (99% likelihood), preferences reversed, such that individuals would pay more to avoid the affect-poor outcome than the affect-rich one. Thus, the affect-rich outcome was more aversive at a low probability and the affect-poor monetary loss became more aversive at a high probability. This inconsistency in preference was replicated with other affect-rich outcomes (potential kisses from movie stars, European vacation coupons), suggesting that the method for weighting probabilities of outcomes relies on the nature of the outcome itself (e.g., affect-rich versus affect-poor).

A standard assumption of traditional models of decision making under risk is that choice is based on a process that resembles calculation of expectations. These expectations are sums based on the multiplicative combination of the subjective value, or utility, of outcomes and their respective probabilities. Whereas research has demonstrated that expectation-based models can often provide a good fit for choices among outcomes that are relatively affect-poor (Glockner & Pachur, 2012), the results of studies by Pachur and colleagues demonstrate that these models may not describe affect-rich choice as well. Specifically, their results showed that individuals tend to make decisions consistent with using strategies that discount or even ignore probability when making choices about affect-rich outcomes compared with those that are affect poor.

To investigate how choice and strategy use are influenced by the presence of affect, Pachur and colleagues (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Herwig, 2015) used a lottery task to examine preferences for outcomes that elicited strong affective feelings (medical side effects or hotel amenities) versus those that did not (monetary outcomes). In one affect-rich context, participants indicated their preferences by making choices between medications that each had a specified side effect that would occur with some probability, otherwise no side effect would occur. Figure 1 shows an example of one of their lottery pairs involving side effects. The top lottery, Medication A, presents a 15% chance of experiencing fever and an 85% chance of no side effects, while the bottom lottery, Medication B, presents a 10% chance of experiencing insomnia and a 90% chance of no side effects.

Medication A: With a probability of 15% the medication leads to fever as a side effect,
With a probability of 85% no side effects occur.

Medication B: With a probability of 10% the medication leads to insomnia as a side effect,
With a probability of 90% no side effects occur.

Figure 1. Example affect-rich stimuli from Pachur & Galesic, 2012.

To make comparisons between choice behavior in affect-rich and affect-poor domains, affect-poor equivalents needed to be constructed. To create these lotteries, the researchers generated monetary outcomes using a willingness-to-pay (WTP) task. WTP is a way to estimate the value that someone places on a commodity. It is a form of contingent valuation, in which preferences are revealed through the monetary amount an individual is willing to pay to acquire a desired commodity or avoid an undesirable commodity. In the WTP task used by Pachur and colleagues, participants indicated how much they would be willing to pay to avoid the possibility of a side effect.

Utilizing the WTP task, monetary equivalents were generated for each of the possible affect-rich outcomes. These equivalents were paired with the same probabilities utilized in the affect-rich lotteries to create the affect-poor lotteries for choice, an example of which is displayed in Figure 2.

Lottery A: With a probability of 15% you lose $20,
With a probability of 85% you lose nothing.

Lottery B: With a probability of 10% you lose $25,
With a probability of 90% you lose nothing.

Figure 2. Example affect-poor stimuli from Pachur & Galesic, 2012.

Decision behavior under risk was assessed in affect-rich and affect-poor contexts by comparing the proportion of choices of the lottery with the higher expected value (EV), which refers to the average amount that would be won or lost if playing the lottery many times. It is calculated by multiplying the monetary outcome by the paired probability. For example, in a lottery that presents a 10% chance of winning $50, the EV of that lottery is $5 (i.e., $50 x .10 = $5). The WTP value obtained in the affect-poor lotteries was also used as an estimate of EV in the affect-rich lotteries. For example, the WTP value associated with insomnia would be utilized with the probability displayed in the lottery containing insomnia for the purpose of determining that lottery's EV.

In their studies, Pachur and colleagues repeatedly found that individuals selected the lottery with the higher EV more often in the affect-poor than affect-rich context; thus, exhibiting a pattern of preferences that would be better in the long run in the affect-poor context. This was true even though the problems were matched to be monetarily equivalent. The results demonstrated that participants had systematically different preferences for a lottery pair when it was presented in affect-rich terms than when it was presented as an ostensibly equivalent lottery pair with affect-poor monetary outcomes. Pachur and colleagues (2014) refer to as the "affect gap," signifying that differences in choice exist because of the presence of affect.

To help explain why the affect gap occurred, Pachur and colleagues examined the potential strategies that might have been used in each affective context. With the goal of modeling the underlying cognitive processes contributing to this affect gap, the researchers' explored strategies that take probability into account, EV calculation, as well as others that do not. One example of a strategy that does not utilize probability is minimax, in which an individual selects the lottery with the least bad outcome to minimize the maximum regret that could be associated with incurring the worst outcome. In the gain domain the counterpart is a maximax strategy, in which an individual selects the lottery with the best outcome to try and maximize the best feeling, which is associated with the highest payoff. The examination of strategy use revealed differences in the strategies that were utilized in affect-rich and affect-poor choices. For affect-poor problems, choices were best described by the use of EV calculations, which takes probability into account. Conversely, in the affect-rich problems, the dominant pattern of preferences was most often consistent with strategies that ignore probability, such as minimax or a maximax. As an additional step to test the acquisition of probability information in choice, the authors utilized a process tracing methodology to analyze how often participants chose to acquire information on probability versus outcomes. Both probability and outcome information was "hidden," and participants clicked on the respective boxes to reveal the appropriate information. Results demonstrated that both probabilities and outcomes were acquired equally in affect-poor problems; however, probability information was acquired less than outcomes in affect-rich problems. In the affect-rich context, individuals tended to focus more on the outcomes upon which the decision was being made.

Pachur and colleagues (2014) further examined whether differences in choice are due to differences in probability weighting, by fitting choices in both the affect-rich and affect-poor task to cumulative prospect theory (CPT; Tversky & Kahneman, 1992). CPT is an expectation-based model that allows for weighting on both the outcome and probability. It utilizes a subjective value function to transform objective values, as well as a decision weighting function for likelihoods. Pachur and colleagues (2014) were interested in testing a hypothesis previously put forth by Rottenstreich and Hsee (2001), which posited that affect-rich choice is characterized by a more strongly inverse S-shaped probability weighting function. This shape would indicate probability discounting in choice because a change in objective probability is not proportional to the change in the subjective decision weight. Results supported this hypothesis in the affect-rich domain. However, a comparison of CPT and minimax for affect-rich choice revealed that both models similarly accounted for choice. Therefore, Pachur and colleagues (2014) concluded that individuals are at least discounting, if not ignoring, probability when making decisions in the affect-rich context.

In a follow up study, Suter, Pachur, and Hertwig (2015) utilized the same paradigm to further assess to what extent individuals are sensitive to probability in affect-rich choice. In previous research, Pachur and colleagues (2014) used aggregate data to understand the strategies behind choice; however Suter, Pachur, and Hertwig (2015) were interested in identifying how probabilities are weighted at the individual level. To do this, they fit individual choices in the lottery task to CPT and the minimax strategy (Savage, 1951). They found that CPT, which is a strategy that incorporates probability, was a better model fit for affect-poor choices than affect-rich choices. Moreover, in the affect-rich lottery problems, the proportion of individuals best described by minimax, which is a strategy that ignores probability, was notably higher. Thus, the pattern of model fit provided evidence that individuals are less inclined to utilize probability in the affect-rich lotteries.

In an effort to explore the neurocognitive mechanisms behind the strategies involved in affect-rich and affect-poor choice, Suter, Pachur, Hertwig, Endestad, and Biele (2015) uncovered evidence of differences in processing for choices in these contexts. The authors were interested in testing the generalizability of expectation-type calculations in different domains. Specifically, they hypothesized that the neurocognitive mechanisms underlying choice do not generalize across domains. The researchers found that the affect-rich and affect-poor choices recruited qualitatively different brain circuits. The amygdala was more strongly activated in affect-rich choice than affect-poor choice, suggesting greater engagement of affective processing of outcomes. In contrast, areas associated with executive function and calculative processes, such as the supramarginal gyrus and the superior lateral occipital cortex, were more active in affect-poor choice. Furthermore, there was greater activation in brain regions associated with processing probability, for example the supramarginal gyrus and the middle frontal gyrus, in affect-poor choice than affect-rich. Overall, Suter and colleagues' (2015) results suggest that probabilities are utilized to a lesser degree in affect-rich choice, wherein the primary activation occurs in regions concerned with the emotional value of outcomes. Conversely, fMRI activation demonstrated that individuals appear more likely to utilize the available probability information in their decision making when making choices in the affect-poor context.

In the present research, we examine potential causes for the differences in choice for affect-rich and affect-poor outcomes, including the potential that they may be due to probability insensitivity in the presence of affect. If this is the primary driver of differences across contexts, we will attempt to correct this insensitivity by helping individuals appreciate probability information.

Effectively Communicating Probability

Understanding probability can be a challenging task for a wide range of individuals and it has been suggested that probability is the most difficult aspect of risk to communicate and comprehend (e.g., Bogardus, Holmboe, & Jekel, 1999). Depicting probabilities is not always straightforward, and the potential for misinterpretation and miscommunication about likelihoods can arise even when dealing with risks that individuals may encounter in routine daily life, such as those relating to medical treatments.

Displaying likelihoods visually is one method that has been shown to improve risk comprehension (Lipkus, 2007; Waters, Weinstein, Colditz, & Emmons, 2007; Zikmund-Fisher, Fagerlin, & Ubel, 2008). Visual displays are most effective when they are made transparent through elements that are well-defined, accurate, and not misleading; for example, by making part-to-whole relationships available explicitly. By improving risk comprehension, visual aids can offer many benefits such as increasing risk avoidance when appropriate (Schirillo & Stone, 2005), and encouraging healthy behaviors like vaccination (Cox, Cox, Sturm, & Zimet, 2010).

There are many options for displaying risk information visually, such as the use of bar graphs, pie charts, or risk ladders. However, research has repeatedly demonstrated that the use of icon arrays (also referred to as pictographs or pictograms) are a particularly beneficial supplemental tool for communicating probability information (Galesic, Garcia-Retamero, &

Gigerenzer, 2009; Garcia-Retamero, Galesic, & Gigerenzer, 2010; Waters et al., 2007). Icon arrays utilize a matrix of small images (i.e., icons), often in groups of 100 or 1,000, to show likelihoods of one or more events, such as experiencing a side effect with medication. For example, Figure 3 presents a 10x10 array in which the likelihood of experiencing a side effect from medication, 30%, is displayed as the circles with Xs marked in them. Research has suggested that icon arrays are particularly beneficial for communicating risk statistics because they utilize frequency information by showing the number of individuals that are affected given a sample of specified size (Waters et al., 2007). Several studies have shown that frequencies tend to be much easier to process and understand than more abstract values such as probabilities or odds ratios (Gigerenzer & Hoffrage, 1995; Hoffrage & Gigerenzer, 1998; Schapira, Nattinger, & McHorney,). In addition, icon arrays make differences between those affected and not affected more apparent than other visual formats such as bar graphs (Waters et al., 2007).

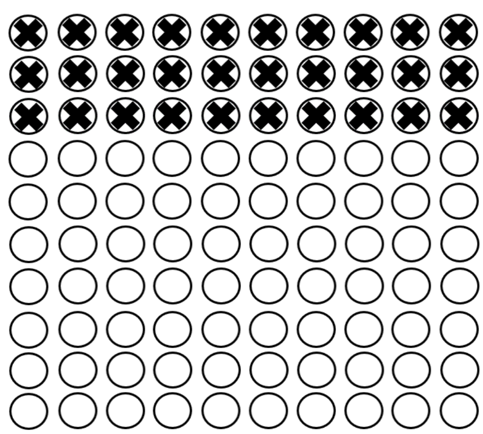


Figure 3. Example icon array displaying a 30% probability of outcome occurrence.

Research has demonstrated that icon arrays assist in comprehension of numerical risks (Hawley et al., 2008) and improve accuracy (Galesic et al., 2009; Garcia-Retamero & Galesic, 2010; Waters et al., 2007). For example, Waters and colleagues (2007) showed that, compared with presenting information as numbers only, adding an icon array substantially reduced side effect aversion, which is the tendency to avoid a beneficial or needed treatment because of the presence of a side effect. In other words, using the icon array increased the willingness to undergo the beneficial treatment despite the minor increase in a chance of experiencing a side effect associated with taking a medication. Furthermore, adding an icon array improved individuals' accuracy in indicating that the treatment would result in a reduction in total risk of cancer compared to the numbers only condition, and increased the participants' ability to evaluate a trade-off of the risks and benefits of the treatment.

Research has demonstrated that individuals who struggle with numerical concepts such as risk may be especially helped by the use of icon arrays. The ability to comprehend and utilize numeric information is referred to as one's level of numeracy (Lipkus, Samsa, & Rimer, 2001). There are wide variations in numeracy (Lipkus, Samsa, & Rimer, 2001) and having adequate levels of numeracy is critical for understanding risk, especially when outcomes pertain to health (Peters, Hibbard, Slovic, & Dieckmann, 2007). For example, Pachur and Galesic (2012) found that numeracy level impacted one's ability to select the normatively better option (option with higher EV) when deciding between affect-rich medical side effects and affect-poor monetary lottery pairs. They found the general tendency for individuals high in numeracy to more often selected the lottery with the higher EV, compared to those low in numeracy.

Hawley and colleagues (2008) explored how individuals varying in numeracy are aided by the use of icon arrays. They found that icon arrays lead to some of the highest levels of knowledge about exact numerical information, such as the number of people affected by a treatment, referred to as verbatim knowledge. The icon arrays also helped individuals answer questions on general information about which treatment is better, known as gist knowledge. Using icon arrays was therefore recommended as the best format for communicating both types of information. Furthermore, the arrays remained the recommended format for both those high and low in numeracy, as the use of icon arrays leads to high levels of correct answers for verbatim and gist knowledge questions regardless of level of numeracy.

Galesic and colleagues (2009) found that, especially for individuals low in numeracy, the addition of icon arrays to numerical statements was beneficial for understanding medical risks, such as reducing the risk of stroke or heart attack. Furthermore, Garcia-Retamero and Galesic (2010) found that, among individuals with high graph literacy, the use of icon arrays could improve the level of risk understanding among low numeracy individuals to comparable levels observed in those with higher numeracy. Icon arrays may be especially advantageous for low numeracy individuals because the arrays are able to visually display percentages as frequencies, which are discrete units that effectively communicate part-to-whole relationships (Ancker et al., 2006).

However, there may be differences in how individuals high and low in numeracy process icon arrays. For example, Hess and colleagues (2011) found that those with high numeracy tend to count the number of affected icons displayed in the array. Comparatively, those who have low numeracy are presumed to perceive the graph in a more holistic sense. In fact, Hess and colleagues (2011) found that prompting low numeracy individuals to count the icons can be rather confusing for this group. Thus it appears that while icon arrays are helpful for both high and low numeracy individuals, the reasons behind the helpfulness may be different for each group.

In Study 1 of the proposed research, our goal is to test whether the differences in affect-rich and affect-poor choice found by Pachur and colleagues (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015) are primarily due to probability insensitivity in the presence of affect, and if so, to correct this insensitivity by highlighting and illustrating the relevant probability information. As icon arrays have been suggested as a particularly helpful format for a wide range of individuals, including those who struggle with numerical skills, we will utilize supplemental icon arrays as an alternative to numeric probabilities alone. The proposed research will also explore whether the addition of icon arrays can be particularly helpful for those low in numeracy when information is presented in both an affect-rich and affect-poor context.

Comparability of Outcomes

To make comparisons across affective contexts, Pachur and colleagues assumed that eliciting monetary equivalents utilizing a WTP paradigm would produce an affect-poor value that was comparable in every way to the affect-rich side effects, except that the monetary equivalents have less affect associated with them. However, there is concern about whether the affect-poor "equivalents" elicited by this paradigm are in fact that. Monetary amounts may differ from affect-rich outcomes in more ways than affect alone. These differences include issues such as comparability and precision of outcomes.

Though Pachur and colleagues attribute their findings of discounting probability information to the presence of affect, their results may be due instead to difficulties associated with comparing outcomes that have different attributes from one another. The different side effects to be compared may involve qualitatively different visceral feelings, which could make these options difficult to compare. For instance, the feelings that are associated with experiencing a fever are not likely to be the same as those associated with suffering from memory loss. The side effect of fever may be comprised of attributes on several different dimensions such as chills, weakness, or sweating, whereas memory loss may involve attributes on different dimensions such as confusion, forgetfulness, or challenges in planning. In contrast, the affect-poor outcomes involving money all exist on the same continuum of dollar values.

Because different side effects are comprised of different sets of attributes, they cannot typically be compared on the same scale(s). Options with noncomparable attributes (Johnson, 1984), or nonalignable differences (Zhang & Markman, 2001) are more difficult to compare than those with shared attributes wherein differences occur on the same scale.

Johnson (1984) investigated the strategies behind choices for noncomparable versus comparable outcomes. When outcomes are comparable, people can simply utilize a within-attribute strategy, comparing alternatives on shared attributes. However, this is not possible when the attributes of the outcomes are not the same. For example, when comparing a television to a stereo, it is hard to say which is better or worse as they don't share attributes such as screen size, picture quality, and internet capability. One strategy for dealing with these incompatibilities involves making decisions at the level of overall evaluations. Thus, the evaluations of the individual option attributes of screen size, picture quality, sound quality, etc., may be summed to create an overall evaluation of worth for the television. This could be compared to the summation of the attributes volume, sound quality, and size for the stereo. Developing this overall evaluation based on pooling across attributes is relatively effortful, and is typically not the preferred strategy.

A more popular strategy is to compare within attributes, but this is not straightforward when the options involve noncomparable alternatives. In this case, abstraction is required to create attributes that are representative of all options in a decision set. For example, if comparing a television and a stereo, the attribute “frequency of use” may be used for comparison. These higher level abstractions are not necessary when comparing options that share the same attributes, especially when option values are on a single dimension (e.g., dollars).

Because people prefer within-attribute strategies, Johnson (1984) suggested that when outcomes are noncomparable, people seek out ways to compare the outcomes through higher levels of abstraction. As the level of abstraction increases for each attribute, the attribute becomes more common to an increasing number of alternatives, which facilitates comparisons. However, Johnson (1984) suggested that there is a point at which the effort to abstract to a sufficient level in a within-attribute strategy becomes greater than the effort required to compare alternatives in an across-attribute strategy. Therefore, he predicted that as alternatives increase in noncomparability, the typically easier within-attribute decision strategy would be abandoned, and they would shift instead to the less desirable across-attribute strategy.

To examine these hypotheses individuals were asked to make comparisons between options that were judged to be comparable (e.g., two televisions), moderately noncomparable (e.g., a television and a stereo), or more noncomparable (e.g., a television and an automobile). Individuals were asked to make a decision between the two alternatives. They were instructed to think about how the decision between the two options was to be made, with specific instructions to think aloud about the attributes or criteria used in making the decision. Attributes mentioned were then coded for whether a comparison was made on that attribute or whether it was used just as a descriptor of an alternative. Attributes were also rated on a 0-10 point concreteness to abstractness scale.

As predicted, results demonstrated that as the options in a pair became more noncomparable, the level of abstractness of the attributes describing the options increased. For example, one of the most common attributes for moderately noncomparable options was "use," whereas for more noncomparable options "necessity" and "importance" were the most common. Additionally, individuals generally retained a within-attribute decision strategy; however, gradually shifted to an across-attribute decision strategy as alternatives become more noncomparable.

Because the affect-rich side effects involve many noncomparable attributes, choices between different side effects may require higher levels of abstraction than choices between different amounts of money. In a follow-up paper, Johnson (1986), noted that abstracting is likely to become a more effortful process as the number of abstracted attributes increases. Therefore, additional cognitive effort may be needed to abstract and make comparisons between the side effects. As Johnson (1986) notes, comparisons on price do not require this kind of abstraction.

In related work, Zhang and Markman (2001) have found that decision making between options is more difficult when options have fewer commonalities, or alignable differences, and more nonalignable differences. Alignable differences are those in which items have corresponding elements with different values on the same dimension. Comparatively, a nonalignable difference is one in which an aspect of one item does not have a corresponding element in the other item. Zhang and Markman (2001) introduce the example of a comparison between two brands of popcorn. Popcorn A is covered in butter, pops in a bag, and contains citric acid. Popcorn B is covered in butter, pops in a bowl, and does not contain citric acid. In this example, an alignable difference is the method for popping the popcorn: either in a bag or in a bowl. It is an alignable difference because both types of popcorn share the property of how the popcorn is popped; however, the aspects of this property (the bag or bowl) are different. A nonalignable difference is the presence of citric acid, as this creates an element that is present in one type of popcorn, but not the other.

Zhang and Markman's (2001) research supports the idea that when making a decision between Popcorn A and B, individuals are more likely to utilize the information pertaining to the alignable difference of how the popcorn is popped (e.g., in a bag or in a bowl), than the nonalignable difference of whether or not citric acid is an ingredient. Compared with alignable differences, nonalignable differences require more processing effort because they are difficult to incorporate into the comparison. Additionally, nonalignable differences are harder to utilize when making tradeoffs between options because there is less shared information for making comparisons. Similar to noncomparable alternatives, making comparisons between options with nonalignable differences is difficult because the attributes that make up an option are unique to that option and cannot be adequately compared with the unique attributes of another option.

The difficulties associated with noncomparable and nonalignable differences serve as a potential alternative explanation of the results of Pachur and colleagues. Unlike money, different side effects have different attributes, which makes them harder to compare. This difficulty, and not the proposed insensitivity to probability in the presence of affect, may explain why people tend to have trouble selecting the option with the higher expected value. Regardless of whether affect is involved, the presence of noncomparable attributes may make comparing side effects more difficult than comparing monetary amounts.

In Study 2 of the proposed research, we address the potential problem associated with noncomparable outcomes by creating a set of side effect outcomes wherein all differences are alignable. Instead of comparing different side effects in each choice, individuals will make comparisons between the same side effects with varying degrees of severity (e.g., comparing some chance of slight insomnia to some chance of moderate insomnia). This will allow for choice between outcomes to be on the same scale, and thus high in comparability as options share the same set of attributes. Thus, in this manipulation of affect-rich side effects, we will test whether differences between affect-rich and affect-poor contexts remain even after eliminating the possibility that differences in choice might be due to differences in the comparability of outcomes or alignability of attributes. If affect itself influences choice, differences in preferences between the affect-rich and affect-poor conditions should remain. If instead, preference differences were caused by differences in comparability rather than affect, then the preference differences should be reduced or disappear.

Precision of Outcomes

Another feature of outcomes that differs in the affect-rich and affect-poor conditions in the work of Pachur and colleagues involves the precision of outcomes. In their affect-poor lottery task, individuals make decisions between possible monetary outcomes, which not only allow for comparison on the same scale with the same attributes, but also provides a precise quantitative representation. In contrast, the affect-rich medical side effects lack the same precision and quantitative representation.

Much of the difference in precision derives from the fact that the affect-poor outcomes are numerical whereas the affect-rich outcomes are conceptual and non-numerical. As noted by McGraw, Shafir, and Todorov (2010), the use of non-numerical outcomes may impair one's ability to easily integrate outcomes and probabilities into a summary evaluation. This type of integration is required for calculating EV, which is the criterion used in the Pachur, et al., task to evaluate the quality of choice performance. It may be that performance was found to be superior in the affect-poor monetary conditions simply because calculation of EV is more straightforward when combining two exact numbers: a probability and a dollar amount. Calculating EV is likely to be more difficult when combining a probability with a non-numeric concept of a side effect. Therefore, the original findings, which Pachur and colleagues attribute to affect, could be due instead to difficulty combining outcomes and probabilities to determine worth in affect-rich choice.

This possibility is supported by McGraw, Shafir, and Todorov (2010) who found that the psychological valuation of monetary (i.e., numeric) and nonmonetary (i.e., non-numeric, for example, washing dishes) outcomes is distinct. Their research demonstrated that when making decisions about monetary outcomes, the expected tendency to determine worth through a combination of outcome and probability values holds. However, when making decisions about nonmonetary outcomes, individuals do not intuitively assign a monetary value to the outcome, which would hinder utilization of a strategy that combines probability and outcome values to determine worth. The absence of a numeric outcome resulted in decreased sensitivity to probability for the choices involving nonmonetary outcomes presumably because it was not possible to combine the numeric probability information with the nonnumeric outcome information. Further, as a result of the decreased sensitivity to probability, individuals were likely to hold different preferences for monetary and nonmonetary outcomes when the probability of those outcomes was low versus high. In line with previous findings by Rottenstreich & Hsee (2001), McGraw and colleagues (2010) found that individuals show a greater aversion to the nonmonetary (versus monetary) outcomes when they have a low probability of occurrence (1% chance), but show a greater aversion to the monetary (versus nonmonetary) outcomes when they have a high probability of occurrence (99% chance). If preferences were stable and sensitive to probability, you would expect that the outcome that is preferred at 1% likelihood would also be preferred at 99% likelihood; however, this was not the case. This pattern of preferences and decreased sensitivity to probability, which has previously been attributed to affect-richness (Rottenstreich & Hsee, 2001), remained despite the monetary outcomes being regarded as more affect-rich than the nonmonetary outcomes. Therefore, rather than the presence of affect, a potential explanation for the differences found by Pachur and colleagues may be a discrepancy in how individuals calculate worth of monetary and nonmonetary outcomes in choice, and how this discrepancy enables or inhibits use of probability information.

To counter this argument, Suter, Pachur, and Hertwig (2015) revised the original methodology used by Pachur and colleagues (2014) in an attempt to show that the addition of numeric values to the affect-rich outcomes would not eliminate the differences in ability to choose the higher EV lotteries in the affect-rich versus affect-poor context. Half of participants viewed the side effects displayed along with the respective WTP values that they provided earlier, whereas the other half saw only the side effect with no supplemental WTP value. The researchers found that including the respective WTP values with the affect-rich lotteries did not influence the proportion of choices of the higher EV lottery. Participants continued to more often choose the option with the higher EV in the affect-poor than affect-rich lotteries, which replicated the findings of Pachur and Galesic (2012) and Pachur and colleagues (2014). With these results, the authors concluded that the differences between the affect-rich and affect-poor choice were not due to the presence of numerical vs. non-numerical information. However, simply adding a relatively abstract numeric value to the affect-rich side effects (e.g., a monetary amount paired with a side effect) may not adequately address the problem if the side effects are fundamentally hard to compare and also less precise than the affect-poor monetary outcomes.

Monetary outcomes are highly precise, with a clearcut meaning associated with different values. Side effects are much less precise in their meaning, as are most constructs communicated in normal everyday language. According to fuzzy set theory, most language constructs function to categorize our world and these categories typically have fuzzy membership gradations (Smithson & Oden, 1999). For example, when describing the color blue, there is wide variation in what one would classify as blue. Baby blue, navy, and turquoise could all be classified as belonging to the category of blue; however if you asked your friends to describe the color blue, without further specifications, you are likely to elicit different responses. This type of fuzzy membership is the norm in language. For example, a concept as simple as a cup has a wide range in which characteristics can vary without compromising the applicability of the term (e.g., it could be tall or short, wide or narrow, and with or without a handle).

More abstract concepts such as probability terms are also fuzzy and are subject to interpretation. For example, Wallsten, Budescu, Rapoport, Zwick, & Forsyth (1986) found that there is wide variability in the numeric probabilistic value placed on nonnumeric probability terms such as probable, likely, and possible. The researchers found that even the term toss up, which can be thought of as a coin toss (with 50% probability of each outcome), leads to probability estimates ranging between 40% and 60%. Abstract feelings like those associated with side effects are likely to be fuzzy as well, perhaps even more so than the examples provided above.

The fact that concepts such as side effects are more vague whereas monetary values are precise, may influence choices. Research has demonstrated that individuals differentially value and utilize vague information in choice. For example, Kuhn, Budescu, Hershey, Kramer, & Rantilla (1999) found that preferences vary for vague versus precise information. Using a gambling task, they found a general tendency for vagueness aversion in outcomes, where individuals preferred options when outcomes were presented in more precise terms. This demonstrated that outcome vagueness is important in preferences between options, and this was particularly true when outcomes were in the negative domain. In the context of deciding between side effects and monetary outcomes, preferences may differ simply because of a lack of precision that is inherent to the side effects.

Thus, it is possible that the differences in precision between the affect-rich and affect-poor stimuli are contributing to the alternative patterns of choice seen in each context. For example, the enhanced precision available in the affect-poor choice may aid the EV calculation used in these decisions. Comparatively, the lack of precision inherent in the affect-rich constructs of side effects may complicate or add noise to the EV calculation of the outcomes incorporated in choice.

We will address this concern in Study 3 of the proposed research by making our affect-poor monetary outcomes less precise, while adding a numeric scale to the affect-rich side effects. If side effects are inherently vague constructs, providing a single numeric value to a side effect outcome may not adequately capture the meaning communicated by the construct. Therefore, for the affect-rich context, we will add a numerical range of side effect intensity. To better align the precision of the outcomes in the affect-rich and affect-poor contexts, we chose to introduce a similar lack of precision into the affect-poor condition by replacing specific monetary values with ranges of monetary values. In both cases, the outcomes will have both numeric and language labels to further match the conditions in the event that the presence of numbers is required to gauge the EV of options.

Present Research

In a series of three studies, we sought to challenge and expand on the work of Pachur and Galesic (2012), Pachur and colleagues (2014) and Suter, Pachur, and Hertwig (2015). Our primary goal was to explore potential explanations for the affect gap found in choices for affect-rich and affect-poor outcomes. We did this by examining how probability display as well as outcome comparability and precision influence choice in affect-rich and affect-poor contexts.

In Study 1, we sought to replicate and extend the results of Pachur and colleagues (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015) by exploring a remedy for the affect gap through increasing sensitivity to probability via a visual representation of likelihoods. In addition to the numeric probability conditions, we included conditions with icon arrays to visually represent, and make salient, probability information in both the affect-rich and affect-poor contexts.

In Study 2, we explored the potential for differences in nonalignability of outcomes to be a substantial contributor to the differences in choice between affect-rich and affect-poor outcomes. In this study, we brought the affect-rich side effects into alignment by using outcomes in each choice that represent different levels of severity on the same side effect continuum (e.g., 20% chance of a slight insomnia versus 10% chance of a moderate insomnia). We investigated whether the established pattern of choice for affect-rich versus affect-poor prospects remains.

In Study 3, we evaluated whether the lack of precision that exists in the affect-rich outcomes could be contributing to the differences in choice between contexts found by Pachur and colleagues. In this study, we explored how decisions are made when the precise information about an outcome is not available, as is typically the case when dealing with affective constructs. To do this, we used outcomes represented as belonging to a category with a range of values. We continued to employ the use of comparisons of the same alignable side effects varying in severity that were created for Study 2. However, in Study 3, the affect-poor values were represented as a range of monetary values and described in natural language terms (e.g. $15-$29 representing a "small" amount of money). The use of a range of numeric values was meant to create a similar lack of precision in both the affect-rich and affect-poor outcomes, allowing for comparisons of outcomes that are more equivalent with regard to level of precision. Because the monetary categories still included numeric values, we matched this in the affect-rich condition using range values for each named category from a commonly-used numbered discomfort intensity scale (e.g., intensity 1-3 representing a "slight" fever).

Though the present research is described as three separate studies, the research was conducted concurrently as one large randomly counterbalanced study. Assignment to Study 1, 2, or 3, was counterbalanced across study sessions. We conducted the research in this manner to allow for comparisons to be made across all conditions, regardless of whether it was labeled as Study 1, 2, or 3. Through an exploration of probability presentation methods and comparability of outcomes, this research advanced our understanding of potential influences on choice behavior in scenarios more and less rich with affect.

STUDY 1

The purpose of Study 1 was to replicate and expand on the work of Pachur and colleagues (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015) by increasing sensitivity to probability information. In this study, we manipulated the representation of likelihoods in affect-rich and affect-poor contexts by comparing choices when probability is displayed as a numeric probability only versus a numeric probability that is also depicted visually within an icon array. Based on previous findings (Galesic et al., 2009; Garcia-Retamero & Galesic, 2010; Waters et al., 2007), we expected that the presence of the icon array would bring increased attention to probability, and help clarify how the probabilities in the two options compare to one another.

The specific hypotheses were as follows:

S1-H1: Because icon arrays are expected to help individuals pay attention to and utilize probability information, we expected a greater proportion of choices for the higher EV lottery when the icon array is available than when it was not.

S1-H2: Based on Pachur and colleagues' previous findings, individuals were predicted to choose the higher EV lottery more often in the affect-poor than the affect-rich context.

S1-H3a: If differences in choice were due predominantly to probability insensitivity in the presence of affect, we expected there would be a greater increase in the proportion of higher EV lottery choices with the addition of an icon array in the affect-rich context than in the affect-poor context. That is, the addition of the icon array would be especially helpful in the affect-rich context.

S1-H3b: If the differences in choice were due predominantly to characteristics of outcomes, we expected a greater increase in the proportion of choice for the higher EV lottery with the addition of an icon array in the affect-poor context than in the affect-rich. That is, the addition of the icon array would be especially helpful in the affect-poor context, where outcomes are more easily compared to one another and integrated with probability information.

S1-H4: As was found previously in Pachur and Galesic (2012), we expected to see a main effect of Numeracy. We predicted that individuals high in numeracy will make a greater proportion of choices for the higher EV lottery than those low in numeracy.

S1-H5: Although individuals high in numeracy were expected to choose a greater proportion of higher EV lotteries than those low in numeracy in both the numeric and the icon array conditions, individuals low in numeracy were expected to get a larger boost in performance with the addition of the icon array, so that differences in advantageous choice between those high and low in numeracy would be smaller in the icon array condition than in the numeric condition.

Method

Participants

One hundred thirty-one participants enrolled in a psychology course at a large urban university were recruited to participate in the study through an online system. They were compensated with extra credit in a psychology course of their choosing. Based on a power analysis, in order to be in a position to find a medium effect size with power = .80 and alpha = .05 when comparing four independent groups, we needed 114 participants. After eliminations, we were left with 117 participants for analysis. Fourteen participants were eliminated from the data set. As not to include participants with more than 20% tied/missing data for our primary lottery task, we eliminated individuals if their total number of trials in each affective context fell below 15 (out of a possible 18 trials). This included eliminations for cases in which the higher EV lottery could not be determined (following Pachur, personal communication, December 18, 2017). This may have occurred in certain instances because individuals provided their own WTP values, and when these values were combined with the probability for each lottery in a trial, tied EV for both lotteries in a pair may have resulted. Seven participants were eliminated for having greater than 20% of tied EV lotteries/missing data in the primary lottery task.

An additional three participants were eliminated for not following the instructions in the willingness-to-pay task (as described in the procedure), and four were eliminated for failing the affective evaluation manipulation check (i.e., indicating the same affective value for each side effect).

Design

We utilized a 2x2 Probability Display x Affective Context mixed design. Probability Display was a between-subjects manipulation of the probability display with two levels: numeric or icon array (+array). Affective Context was a within-subjects variable representing the affect-rich side effects versus the affect-poor monetary outcomes.

To capture how individuals make choices between risky options, the primary dependent variable was the proportion of choices of the higher expected value lottery out of 18 lottery pairs. Expected value for each gamble was computed by summing the product of the probability and outcome monetary equivalent generated in the WTP task. To document that our affect-rich outcomes were more affect-rich than the affect-poor outcomes, we measured the intensity of affect generated by the thought of experiencing each possible outcome (side effect or equivalent monetary loss) on a scale of 1 = not at all upset to 10 = very upset. Consistent with the work of Pachur and colleagues (2014), participants rated the amount of affect they would feel if having to experience a given side effect in the affect-rich domain, and rated their level of affect if required to pay a specified amount of money after losing a bet in the affect-poor domain.

Numeracy was measured with the Abbreviated Numeracy Scale (Weller et al., 2013). The ANS examines objective levels of numerical ability through assessment of numerical concepts such as risk and probability. The ANS is rather new; however, it was created by combining items used in previous numeracy measures (Frederick, 2005; Lipkus et al., 2001; Peters et al., 2007; Schwartz, Wolshin, Black, & Welch, 1997). The scale has demonstrated sufficient reliability and validity (Cronbach's $\alpha = .71$; Weller et al., 2013), and results in scores that are more normally distributed than other available numeracy assessments (e.g., Weller et al., 2013).

Stimuli

Affect-rich and affect-poor stimuli were used in the lottery task. A total of 12 side effects borrowed from Pachur and colleagues (2014) and displayed in Table 1, were used to create the affect-rich stimuli. The affect-poor stimuli were created independently for each participant at the time of the study through a WTP task, which is described in detail in the procedure. Table 1 presents the median WTP values gathered by Pachur and colleagues (2014) as well as median values we collected from 135 USF psychology undergraduates in a pilot study used to build the stimuli. As can be seen, in most cases, the values are quite similar across studies.

Table 1.

Twelve Side Effects and Corresponding Median WTP Values from Pachur et al. (2014) as Well as Median WTP Values for a Pilot Study of 135 USF Psychology Undergraduates

Side effect	Pachur et al. (2014) Median WTP	Pilot Study Median WTP
Memory loss	-50	-50
Depression	-35	-30
Hallucinations	-30	-40
Speech disorder	-30	-40
Dizziness	-20	-10
Insomnia	-20	-25
Flatulence	-15	-10
Itching	-15	-10
Trembling	-15	-15
Diarrhea	-10	-20
Fatigue	-10	-15
Fever	-10	-15

The affect-rich side effects and each participant's generated WTP values for the corresponding affect-poor outcomes were each paired with probabilities and incorporated into lottery pairs. These lottery pairs were the stimuli presented in each trial of the numeric or +array condition. We utilized all 13 lottery pairs from Pachur and colleagues (2014), with a minor adjustment to one lottery, wherein the probability was adjusted from 0.5% to 1% to effectively display the value in the icon array. An additional 5 lotteries were created and included in anticipation of needs in Studies 2 and 3. The lotteries are similar to the range of probabilities, EV, and EV differences as the original 13. The complete set of lotteries is displayed in Table 2.

Table 2.

Set of 18 Affect-rich Lottery Pairs (Showing Only Non-Zero Outcomes) to be Used in Study 1

	Lottery A		Lottery B	
	Side effect	Probability of experiencing side effect (%)	Side effect	Probability of experiencing side effect (%)
Original Lotteries	Flatulence	70	Diarrhea	40
	Trembling	50	Itching	60
	Fatigue	70	Dizziness	30
	Speech disorder	30	Memory loss	20
	Depression	30	Insomnia	55
	Hallucinations	20	Fever	40
	Itching	70	Depression	25
	Memory loss	25	Fatigue	90
	Flatulence	100	Hallucinations	25
	Depression	50	Memory loss	10
	Fever	30	Hallucinations	1*
	Itching	50	Depression	1
	Memory loss	10	Insomnia	20
New Lotteries	Fatigue	40	Speech Disorder	20
	Diarrhea	80	Trembling	30
	Dizziness	30	Memory loss	10
	Insomnia	40	Memory loss	10
	Dizziness	70	Hallucinations	30

Note: * denotes probability altered from 0.5% in original lotteries used by Pachur et al. (2014) to 1% in the current research

Each lottery pair involves two lotteries depicting a non-zero outcome with some probability, otherwise nothing. Figure 4 displays an example of how the affect-rich numeric lottery pair appeared. As can be seen, the lottery on the left, Medication A, displays a 20% chance of experiencing insomnia, otherwise no side effect, and the lottery on the right, Medication B, displays a 10% chance of experiencing memory loss, otherwise no side effect.

Medication A:

20% chance of **insomnia** with

80% chance of no side effect

Medication B:

10% chance of **memory loss** with

90% chance of no side effect

Figure 4. Example affect-rich numeric lottery pair.

The same lottery pairs were used in the affect-rich numeric and +array conditions; however, for options in +array lottery pairs, an icon array was also included to visually represent the likelihood of experiencing the medication side effect. Figure 5 provides an example. Each icon array involves a 10 x 10 formation of 100 circles with X's in a subset of circles to represent the chance of experiencing each medication's side effect. As indicated in the written description above the array in the example here, the left panel displays a 20% chance of insomnia, otherwise no side effect, and the right panel displays a 10% chance of memory loss, otherwise no side effect.

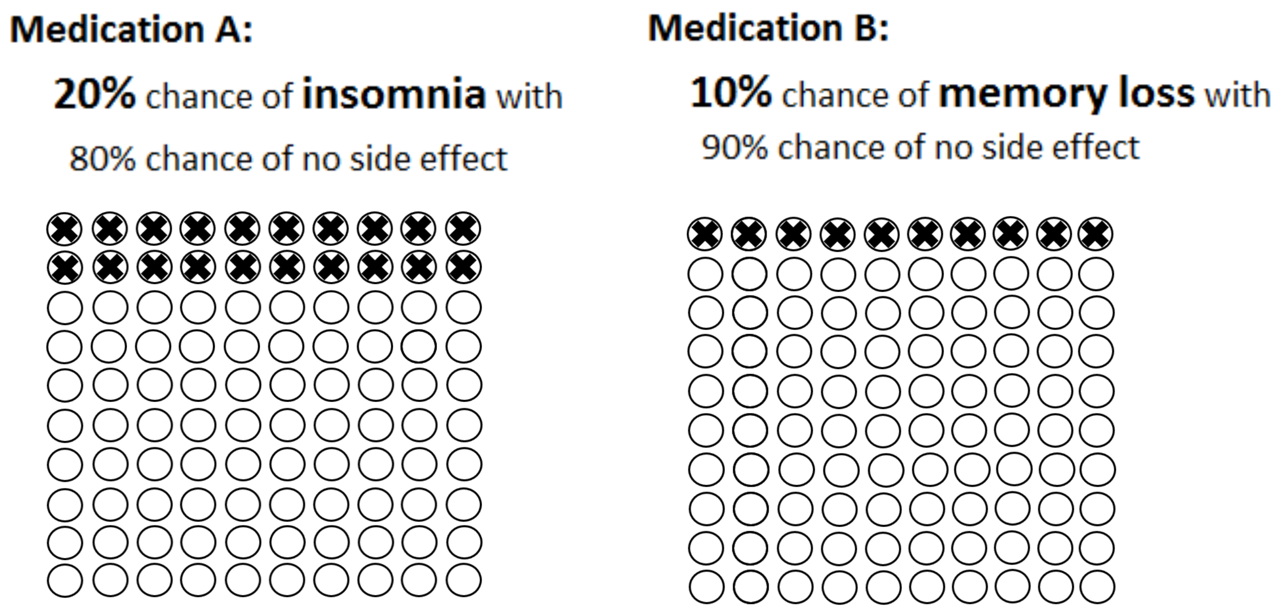


Figure 5. Example affect-rich +array lottery pair.

Each lottery pair displayed in the affect-rich context also had a corresponding lottery pair in the affect-poor context, constructed with the individually-obtained WTP values substituted in for side effects. For example, as is displayed in Figure 6, insomnia has been replaced by an example WTP value of $25, yielding a lottery with 20% chance of losing $25, otherwise nothing. Additionally, memory loss has been replaced by an example WTP value of $50, yielding a 10% chance of losing $50, otherwise nothing.

Lottery A:

20% chance of losing **$25** with

80% chance of losing $0

Lottery B:

10% chance of losing **$50** with

90% chance of losing $0

Figure 6. Example affect-poor numeric lottery pair.

The same affect-poor lottery pair is represented in the +array condition below in Figure 7. This example displays the same lottery as in Figure 6 along with its corresponding icon array highlighting the probability to lose the specified amount of money in each lottery.

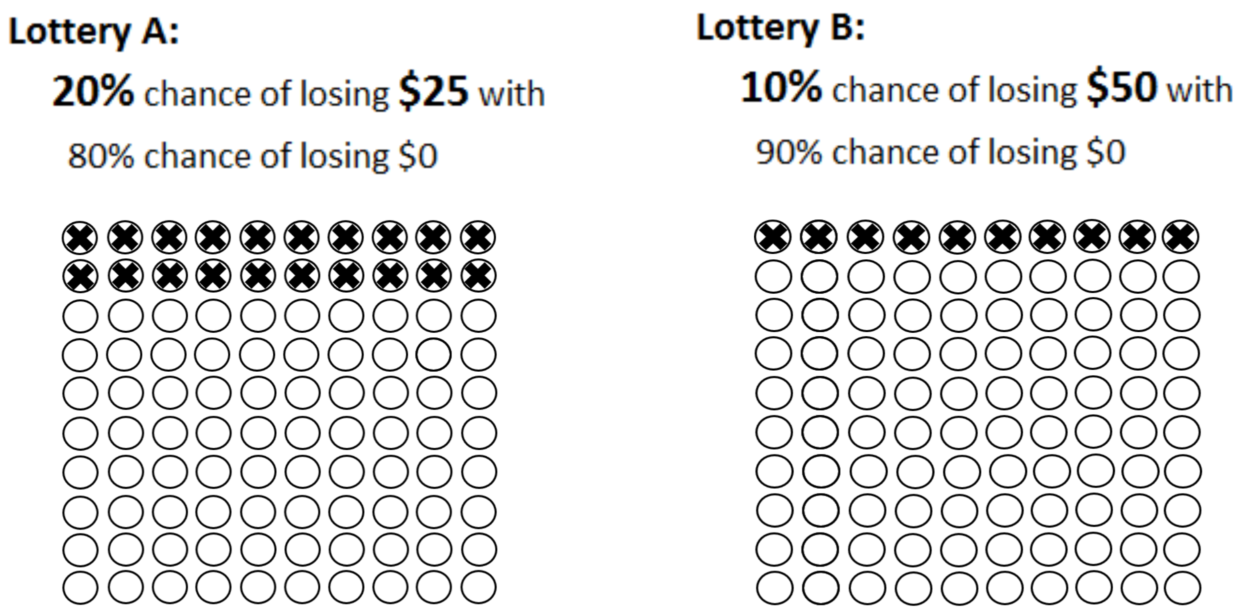


Figure 7. Example affect-poor +array lottery pair.

Procedure

Upon entering the laboratory, participants were given free choice in seating at one of 11 computer stations. Consent to participate and task instructions were displayed on the computer. Each individual experienced both an affect-rich and an affect-poor context in a randomly determined order with either the numeric or +array condition of probability display as randomly assigned.

Participants first completed a WTP task. In this task, participants indicated their WTP values for avoiding each of the 12 side effects if each were guaranteed to occur with 100% certainty. In a modified version of the instructions from Pachur and colleagues (2014), participants were told, “Imagine you have an illness and need to take a medication for 1 week. Two equally effective medications are available to treat the illness. Medication A has a side effect, which is guaranteed to occur, and Medication B has no side effects. For each side effect listed below, please indicate how much extra you would pay for a 1-week supply of the package of the medication with no side effects.” For each of the 12 side effects, presented in a random order, participants indicated the amount, in dollars, that they would be willing to pay extra to acquire the package of medication with no side effects. These WTP values were used as a replacement of the side effect outcome values in the associated affect-poor lotteries.

Next, participants completed the lottery task that contains two parts: one affect-rich and one affect-poor. The order of viewing the affect-rich and affect-poor lottery task was counterbalanced across participants. In the affect-rich condition, participants were told that they have an unspecified illness that will last 1 week and must choose one of two equally effective medications to treat the illness. They were instructed to choose between two lotteries described as Medication A versus Medication B, each of which presents a potential side effect that could occur with a specified probability, otherwise no side effect. (See Figure 4 for a numeric example and Figure 5 for a +array example.) Participants selected which medication they would prefer of the two options in the pair. Participants experienced a total of 18 affect-rich lottery pairs in a random order in the probability display condition that they are assigned.

In the affect-poor lottery problems, participants viewed the 18 randomly ordered lottery pairs with the same probabilities that were seen in the affect-rich task; however, the side effects were replaced by the individual’s WTP amounts gathered at the outset of the study. Participants were told to imagine that they were in a situation in which they must choose between different lotteries that involve potential losses. They were instructed to choose between two lotteries described as Lottery A versus Lottery B, each of which presented a potential monetary loss that could occur with a specified probability, otherwise nothing (see Figure 6 for a numeric example and Figure 7 for a +array example). Participants selected which lottery they preferred from the two options in the pair.

After completion of both parts of the lottery task, participants completed the affective evaluation task, which served as a manipulation check. In this task, participants rated the affect associated with each outcome that was viewed in the affect-rich and affect-poor lottery task. Affect-rich and affect-poor outcomes were presented in a random order within each context, and the order in which each context was presented was counterbalanced across participants. For the affect-rich affective evaluations, participants were told to imagine that they must take a medication for treatment of an illness and this medication has a side effect that will be experienced with certainty. Participants viewed the 12 side effects used in the lottery task in a randomized order, and, for each, rated how upset they would be to experience the side effect. For the affect-poor affective evaluations, participants were presented with each WTP amount they indicated previously and told that they were to imagine they had lost a bet and must pay that specified amount of money. The WTP values were presented in a random order and the participant indicated how upset they would be if s/he must pay this amount.

The affective evaluation task was followed by the objective numeracy scale. Participants were then thanked for their participation and dismissed from the laboratory.

Results

In what follows, we assessed whether the presence of the affect gap was likely due to probability insensitivity. Our first analysis was a manipulation check, testing whether the affect-rich outcomes derived a greater amount of negative affect than the affect-poor outcomes. The primary analysis tested whether increasing sensitivity to probability information in our lottery task through the use of an icon array reduced or eliminated the affect gap. In this analysis we also assessed the potential moderating influence of numeracy.

Monetary and Affective Evaluation

A manipulation check was first conducted to ensure that our affect-rich stimuli generated greater negative affect than our affect-poor stimuli. The mean affect ratings are shown for each affect-rich side effect and its affect-poor monetary equivalent in Table 3. We utilized a repeated measures MANOVA to analyze the affect ratings for the 12 affect-rich side effects and the matched affect-poor monetary values. We found a significant main effect of affective context, $F(12, 96)= 6.76$, $p< .001$, $n_p^2 = .46$, confirming that our affect-rich outcomes ($M= 6.37$, $SD= 1.09$) were rated as generating significantly more negative affect on average than the affect-poor monetary equivalents ($M= 5.59$, $SD= 1.49$). Follow-up univariate analyses indicated that each of the 12 affect-rich side effects elicited a significantly greater amount of negative affect than its affect-poor monetary equivalent.

Also displayed in Table 3 are the 5^{th}, 50^{th}, and 95^{th} percentile responses for the monetary evaluation task to demonstrate the variability in the WTP values. The WTP values were similar to those obtained previously by Pachur and colleagues (2014) and in our pilot study.

Table 3.

Willingness-To-Pay Percentile Values for the Affect-Rich Outcomes, and Mean and Standard Deviations of Affective Ratings for the Affect-Rich Outcomes and Their Affect-Poor Monetary Equivalents

	Willingness-to-pay percentile			Affect Ratings		
				Affect-rich outcome	Affect-poor outcome	95% CI of difference
Affect-rich outcome	5%	50%	95%	*M (SD)*	*M (SD)*	*M (SD)*
Memory Loss	-500	-50	-5	9.23 (1.52)	8.15 (2.19)	[0.65, 1.51]
Depression	-500	-40	-5	7.82 (2.52)	6.84 (2.71)	[0.39, 1.57]
Hallucinations	-255	-40	-5	8.04 (2.40)	6.68 (2.50)	[0.80, 1.92]
Speech disorder	-500	-50	-5	8.32 (1.91)	7.38 (2.35)	[0.45, 1.43]
Dizziness	-200	-20	-2	5.46 (2.12)	4.82 (2.49)	[0.12, 1.16]
Insomnia	-177.5	-25	0	6.55 (2.51)	5.78 (2.72)	[0.18, 1.36]
Trembling	-100	-20	-3	5.70 (2.25)	5.09 (2.51)	[0.07, 1.15]
Itching	-100	-15	0	5.23 (2.52)	4.41 (2.41)	[0.26, 1.38]
Flatulence	-100	-20	0	4.83 (2.37)	4.29 (2.45)	[-0.01, 1.09]
Diarrhea	-100	-20	-2.9	6.20 (2.64)	5.38 (2.63)	[0.22, 1.42]
Fever	-100	-15	-1.9	5.08 (2.41)	4.46 (2.57)	[0.06, 1.18]
Fatigue	-100	-15	0	4.82 (2.36)	4.03 (2.37)	[0.25, 1.33]

Note. CI = confidence interval. The 95% CIs refer to the difference between the average affect rating for the affect-rich side effects and the average affect rating for the affect-poor willingness-to-pay values. Ratings for the affective evaluation ranged from 1 (not upset) to 10 (very upset).

Lottery Task

To assess the hypotheses, a 2x2x2 Probability Display x Numeracy x Affective Context mixed ANOVA was conducted. The results are displayed in Figure 8. The dependent measure for this analysis was the proportion of choices of the higher EV lottery. As described previously, participants were eliminated if having EV ties or missing data for more than three lottery pairs in each affective context. Therefore, the percentage of higher EV choices was computed for each participant out of a possible 15 to 18 total choices in each affective context.

Due to computer error, one question on the Abbreviated Numeracy Scale could not be included in analysis (i.e., “If the chance of getting a disease is 20 out of 100, this would be the same as having a _____% chance of getting the disease"). The reliability of this measure without this item was α= .64, indicating adequate reliability. A median split was used to classify groups into low numeracy (i.e., scores of 0-3; N=58) and high numeracy (i.e., scores of 4-7; N=59) for analysis.

Replicating the results of Pachur and colleagues (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015), there was a significant main effect of affective context, $F(1, 113)= 24.81$, $p< .001$, $n_p^2= .18$, displayed in Figure 8. In support of Hypothesis S1-H2, individuals chose a greater proportion of higher EV lotteries when in the affect-poor (*M*= 78.39%, *SD*= 14.23%) compared to the affect-rich (*M*= 68.96%, *SD*= 14.22%) condition.

Replicating the results of Pachur and Galesic (2012), the main effect of numeracy was also significant, $F(1, 113)= 4.39$, $p= .04$, $n_p^2= .04$, though the effect size was small. As can be seen in Figure 8, individuals high in numeracy had a slightly stronger tendency to choose higher EV lotteries (*M*= 75.56%, *SD*= 9.99%) than those low in numeracy (*M*= 71.75%, *SD*= 9.90%), though both groups showed relatively high levels compared to previous research (e.g., 64% and 59% for those high and low in numeracy, respectively; Pachur & Galesic, 2012). This finding supported Hypothesis S1-H4. To corroborate the results, we ran correlations between numeracy and choice of the higher EV lottery in both affective contexts. Higher numeracy was weakly associated with better choice in the affect-poor context, $r(117)=.19$, $p= .04$, however, there was no discernible relationship between numeracy and choice in the affect-rich context, $r(117)=.08$, *ns*.

We did not find a significant main effect of probability display, $F(1, 113) < 1$, failing to support Hypothesis S1-H1. There was no support for differences in the proportion of choices for the higher EV lottery for those viewing the numeric versus the +array conditions, suggesting that the icon array was not particularly beneficial for choice. Further, contrary to Hypotheses S1-H3a and S1-H3b, we found no significant interaction between probability display and affective context, $F(1, 113) < 1$. Therefore, the addition of the icon array did not have a noticeable effect in either the affect-rich or the affect-poor condition. This suggests that individuals performed just as well without the array as when it was present. Given that performance was high, it casts doubt on the idea that probability insensitivity is leading to differences in affect-rich and affect-poor choice.

As research has demonstrated that individuals low in numeracy are especially aided by the presence of an icon array (Galesic et al., 2009; Garcia-Retamero & Galesic, 2010), we predicted they would receive a larger boost in performance with the array present than those high in numeracy. However, we found no evidence of a Probability Display x Numeracy interaction, $F(1, 113) = 1.72$, *ns,* yielding no support for Hypothesis S1-H5. Furthermore, the Numeracy x Affective Context interaction was not significant, $F(1, 113) <1$, suggesting no evidence of differences in performance in each affective context based on individual numeracy levels. The Probability Display x Numeracy x Affective Context interaction was not significant, $F(1, 113) = 1.33$, *ns.* As shown in Figure 8, the only suggestion of an effect was for the benefit of the icon array in the affect-poor condition for those low in numeracy. An exploratory post-hoc test suggested that for those low in numeracy, choice may have been better in the affect-poor condition when an icon array was present versus absent. This finding is consistent with previous research demonstrating the benefit of icon arrays particularly for this group (Galesic et al., 2009; Garcia-Retamero & Galesic, 2010).

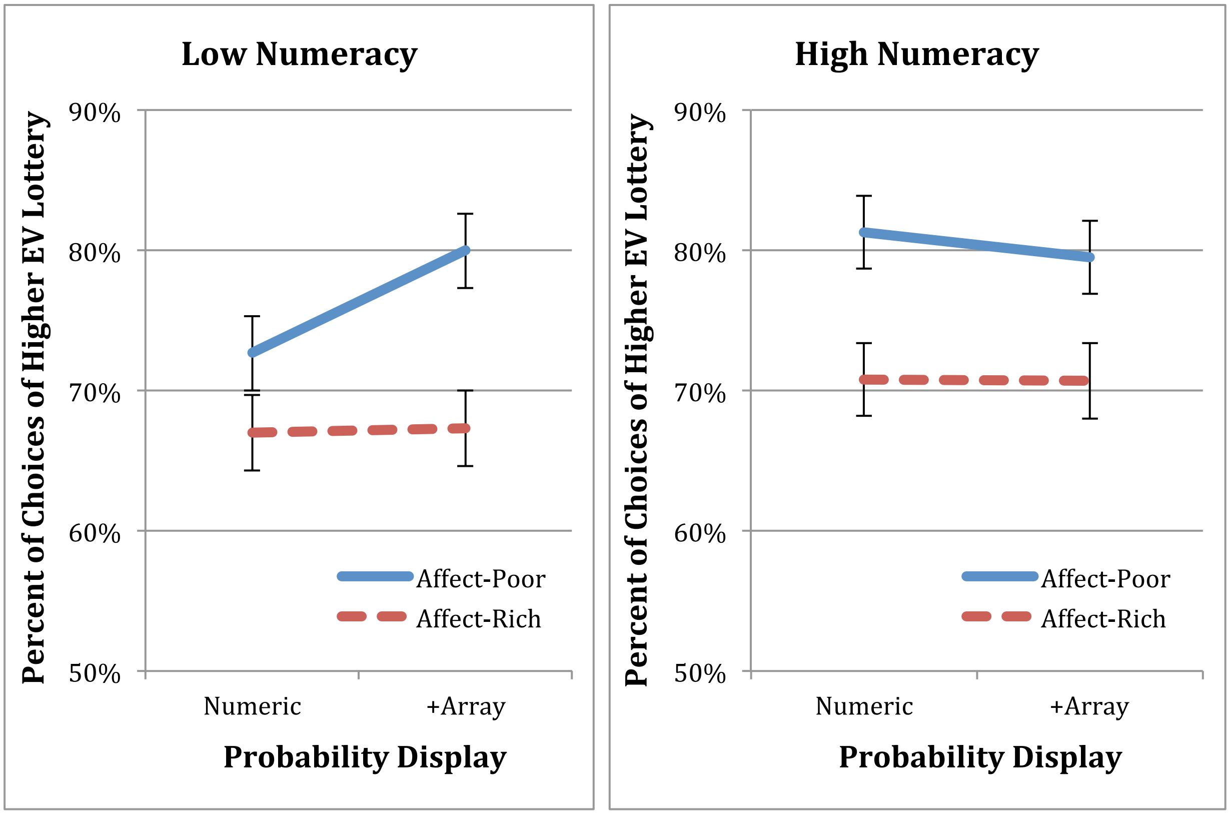


Figure 8. Condition Means for the Probability Display x Numeracy x Affective Context experimental design. Note. The three-way interaction was not significant.

Summary

The results of these analyses replicate the affect gap proposed by Pachur and colleagues (2014), by demonstrating that participants made better choices in the affect-poor monetary outcomes than in the affect-rich side effects. However, the results did not support the primary hypothesis that the gap is caused by neglecting probability information, as the icon array was not particularly beneficial when making decisions about side effects. Furthermore, performance without the array was already rather high, which calls into question the explanation that differences are due to probability insensitivity. Choosing the higher EV lottery requires integration of probability with outcomes, therefore, if individuals were neglecting probability, we would expect that they would not be performing well. As probability insensitivity does not appear to be responsible for the differences seen in affect-rich and affect-poor choice, it leaves the possibility that outcome characteristics could be important. We will address this possibility in Studies 2 and 3.

We found some evidence that if the icon array is going to be beneficial, it will be in the affect-poor context, which may suggest that there is something inherent in the outcomes that is leading to differences in choice. The only instance in which the icon array may have had an effect was in the affect-poor condition for those low in numeracy. This result is in line with previous research, which has shown that low numeracy individuals can benefit substantially from the use of icon arrays (Galesic et al., 2009; Garcia-Retamero & Galesic, 2010). Nevertheless, the lack of an overall effect of the icon array suggests that the manipulation may not have been strong enough to see benefits across numeracy levels in either affective context. However, the possibility also exists that performance levels were already high enough for those high in numeracy (approximately 80% in the affect-poor condition), that reminding individuals of probability information with the icon array simply did not provide any additional benefit.

We did find that individuals high in numeracy were slightly better able to choose the higher EV lottery than those low in numeracy, also replicating previous findings using this paradigm (Pachur & Galesic, 2012). However, instead of finding a general boost in low numerates' performance across affective contexts with the addition of the icon array, we only found evidence for an improvement in the affect-poor context. This suggests that use of the icon array may only be beneficial when working with monetary (i.e., numerically quantified) outcomes.

STUDY 2

In Study 2, we explored whether differences in choice for affect-rich and affect-poor outcomes could be due to differences in outcome comparability. To examine this possibility, we altered the affect-rich condition of this study so that participants made choices between options that involved the same side effect varying in level of severity (e.g., mild versus moderate insomnia). Despite the fact that we did not observe a main effect of Probability Display in Study 1, we continued to explore the effect of this variable, as making the affect-rich outcomes more comparable may elicit differences in the choice process. Our hypotheses for the main effect of Probability Display, the main effect of Numeracy, and the Numeracy x Probability Display interaction were the same as in Study 1.

With respect to the main effect of Affective Context, there were competing hypotheses:

S2-H1a: If differences in choice were due to probability insensitivity when affect is high, we expected to see a similar pattern as that predicted in Study 1. We predicted that choice of the lottery with the higher EV would continue to be greater for affect-poor choice than for affect-rich choice.

S2-H1b: However, if differences were due to outcome comparability, then we predicted that the differences in advantageous choices between the affect-poor and affect-rich context would at least be reduced, or possibly eliminated.

With respect to the Probability Display x Affective Context interaction, there were competing hypotheses:

S2-H2a: If the probability insensitivity hypothesis was the primary driver of differences across affective contexts, we expected findings to be the same as predicted for Study 1.

S2-H2b: However, if the differences were primarily due to characteristics of outcomes (and assuming that explicit numeric outcomes are not essential), then we expected making the affect-rich outcomes more comparable to one another would reduce the size of the interaction, or make the interaction disappear, so that affect-rich and affect-poor choices would be more equally aided by the addition of the icon array.

We also conducted a critical comparison across Study 1 and Study 2 to test the effect of outcome comparability. We did this by comparing the ability to select the higher EV lottery for non-comparable affect-rich outcomes in Study 1 and comparable affect-rich outcomes in Study 2.

S2-H3: We predicted that individuals would choose a greater proportion of higher EV lotteries for affect-rich side effects in Study 2, wherein outcomes are on the same continuum and thus more easily compared, than for the non-comparable affect-rich side effects in Study 1.

S2-H4: We predicted a Comparability x Probability Display interaction. Because outcomes would be more comparable, we expected that choice of the higher EV lottery would be greater for the affect-rich lotteries of Study 2 than Study 1 in both the numeric and +array conditions; however, we expected that aligning the outcomes on the same scale and making the comparisons essentially ordinal in nature in Study 2, would result in a larger boost in choice of higher EV lotteries with the addition of the icon array than affect-rich choice in Study 1. If the interaction was not present, it suggests that the ordinal nature of the scale is not a sufficient proxy for a numeric value, and that the numeric value may be needed to facilitate integrations with probability information.

Method

Participants

One hundred twenty-eight participants enrolled in a psychology course at a large urban university were recruited to participate in the study through an online system. They were compensated with extra credit in a psychology course of their choosing. Based on a power analysis, in order to be in a position to find a medium effect size with power = .80 and alpha = .05 when comparing four independent groups, we needed 114 participants. After elimination of 16 participants, we were left with 112 participants for analysis. As was the case for Study 1, there were some instances in which the lottery with the higher EV could not be determined. Individual trials in which there were equal EVs were eliminated from analysis. Thirteen individuals who fell below a threshold of 20% tied/missing data (i.e., having 3 or more tied EV lotteries/missing choices, out of 18, for gamble pairs in each affective context) were eliminated. Two more participants were eliminated for not following the instructions in the willingness-to-pay task (task described in the procedure), and one was eliminated for failing the affective evaluation manipulation check (i.e., indicating the same affective value for each side effect). Each individual was randomly assigned to view a condition of probability display within an affect-rich and affect-poor context. This study was run contemporaneously with Study 1, and participants were randomly assigned to one of all possible conditions.

Design

Study 2 utilized the same Probability Display x Affective Context design that was used in Study 1. The dependent variable remained the proportion of higher EV options chosen out of 18 choices.

Stimuli

The subset of side effects used in Study 2 was selected based on WTP data from Pachur and colleagues (2014) as well as a pilot study of 135 USF psychology undergraduates. The goal was to include side effects that were rated relatively consistently, but that, as a set, spanned the spectrum of typical WTP values. In the pilot study, participants were asked to provide WTP values for the original set of 12 side effects, as well as six side effects supplemented with the categorical qualifiers of "slight," "moderate," and "severe." The six side effects originally chosen were: headache, fever, dizziness, insomnia, hallucinations, and memory loss. However, in the present study, fatigue was substituted for headache to better align with Pachur and colleagues' (2014) original research. The final six side effects with categorical qualifiers were used to construct the outcomes of the affect-rich lottery pairs in Study 2.

For each lottery pair in the affect-rich conditions, both options described the same potential side effect but differed in terms of the categorical qualifier attached. For example, Figure 9 displays Medication A with a 30% chance of experiencing mild insomnia, otherwise no side effect, versus Medication B with a 10% chance of experiencing moderate insomnia, otherwise no side effect.

Medication A:
30% chance of **<u>mild</u> insomnia** with
70% chance of no side effect

Medication B:
10% chance of **<u>moderate</u> insomnia** with
90% chance of no side effect

Figure 9. Example affect-rich numeric probability lottery pair in Study 2.

The lotteries used were constructed from those in Study 1. To do this, we first looked at the WTP values for the side effects with categorical qualifiers gathered in the pilot study. These values were matched inasmuch as possible to the WTP values for the side effects in Pachur and colleagues (2014), as is shown in Table 4.

Table 4.

Side Effect Outcomes Used in Study 1 and Matched Outcomes with Categorical Qualifier Used in Study 2

	Study 1 Lottery Outcomes				Study 2 Matched Lottery Outcomes			
	Lottery A Outcome		Lottery B Outcome		Lottery A Outcome		Lottery B Outcome	
	Side effect	Pachur et al. (2014) Median WTP	Side effect	Pachur et al. (2014) Median WTP	Side effect	Pilot Study Median WTP	Side effect	Pilot Study Median WTP
Original Lotteries	Flatulence	-15	Diarrhea	-10	Moderate fatigue	-15	Slight fatigue	-6
	Trembling	-15	Itching	-15	Slight fever	-10	Moderate fever	-15
	Fatigue	-10	Dizziness	-20	Slight insomnia	-10	Moderate insomnia	-25
	Speech disorder	-30	Memory loss	-50	Moderate memory loss	-35	Severe memory loss	-50
	Depression	-35	Insomnia	-20	Moderate memory loss	-35	Slight memory loss	-20
	Hallucinations	-30	Fever	-10	Severe dizziness	-30	Slight dizziness	-10
	Itching	-15	Depression	-35	Moderate fever	-15	Severe fever	-30
	Memory loss	-50	Fatigue	-10	Severe insomnia	-45	Slight insomnia	-10
	Flatulence	-15	Hallucinations	-30	Moderate fatigue	-15	Severe fatigue	-6
	Depression	-35	Memory loss	-50	Moderate hallucinations	-35	Severe hallucinations	-50
	Fever	-10	Hallucinations	-30	Slight fever	-10	Severe fever	-30
	Itching	-15	Depression	-35	Moderate dizziness	-15	Severe dizziness	-30
	Memory loss	-50	Insomnia	-20	Severe memory loss	-50	Slight memory loss	-20
New Lotteries	Fatigue	-10	Speech Disorder	-30	Slight fatigue	-6	Severe fatigue	-30
	Diarrhea	-10	Trembling	-15	Slight dizziness	-10	Moderate dizziness	-15
	Dizziness	-20	Memory loss	-50	Moderate insomnia	-25	Severe insomnia	-45
	Insomnia	-20	Memory loss	-50	Slight hallucinations	-20	Severe hallucinations	-50
	Dizziness	-20	Hallucinations	-30	Slight hallucinations	-20	Moderate hallucinations	-35

Note: Slight, moderate, and severe headache were used in the Pilot Study, in place of fatigue. Comparison of WTP values without the categorical qualifier indicated similarities in values, therefore, fatigue was subsitiued for headache. All matches between the pilot study WTP and Pachur and colleagues (2014) original WTP were not more than $5 different.

For example, say the original lottery used by Pachur and colleagues (2014) depicted a 20% chance of hallucinations, otherwise no side effect, versus a 40% chance of fever, otherwise no side effect. The WTP value obtained by Pachur and colleagues (2014) for hallucinations was -$30 and for fever was -$10. These values were then matched to the WTP values obtained for the side effects with categorical qualifiers in the pilot study. Slight and severe dizziness matched these values exactly; slight dizziness had a WTP value of -$10 and severe dizziness had a WTP value of -$30. Therefore, these side effects with the categorical qualifiers replaced the original side effects used by Pachur and colleagues (2014), to create a lottery pair that displayed a 20% chance of severe dizziness, otherwise nothing, versus a 40% chance of slight dizziness, otherwise nothing. The three possible combinations of slight, moderate, and severe were applied to each of the 6 side effects, allowing us to substitute outcomes for each of the 18 lottery pairs used in Study 1. Table 5 displays the complete set of lottery pairs created for Study 2.

Table 5.

Complete List of 18 Lottery Pairs Used in Study 2

	Lottery A		Lottery B	
	Side effect	Probability of experiencing side effect (%)	Side effect	Probability of experiencing side effect (%)
Original Lotteries	Moderate fatigue	70	Slight fatigue	40
	Slight fever	50	Moderate fever	60
	Slight insomnia	70	Moderate insomnia	30
	Moderate memory loss	30	Severe memory loss	20
	Moderate memory loss	30	Slight memory loss	55
	Severe dizziness	20	Slight dizziness	40
	Moderate fever	70	Severe fever	25
	Severe insomnia	25	Slight insomnia	90
	Moderate fatigue	100	Severe fatigue	25
	Moderate hallucinations	50	Severe hallucinations	10
	Slight fever	30	Severe fever	1*
	Moderate dizziness	50	Severe dizziness	1
	Severe memory loss	10	Slight memory loss	20
New Lotteries	Slight fatigue	40	Severe fatigue	20
	Slight dizziness	80	Moderate dizziness	30
	Moderate insomnia	30	Severe insomnia	10
	Slight hallucinations	40	Severe hallucinations	10
	Slight hallucinations	70	Moderate hallucinations	30

Note: * denotes probability altered from 0.5% in original lotteries used by Pachur et al. (2014) to 1% in the current research

The affect-poor portion of the task used lotteries with the same sets of probabilities as those used in the affect-rich context. However, the side effects used in the affect-rich task were replaced by each participant's corresponding WTP value. The WTP task was similar to that described in Study 1. However, the 18 outcomes to be evaluated in this case were the 3 combinations of categorical qualifiers applied to each of the 6 side effects. For example, participants were asked to indicate how much money they would pay to avoid mild insomnia, moderate insomnia, and severe insomnia.

The stimuli for the affective evaluation included the six side effects with each of the three attached categorical qualifiers in addition to the 18 WTP values generated for each side effect.

Procedure

The procedure was the same as in Study 1, with the exception of using the modified side effect stimuli.

Results

In what follows, we assessed whether differences in choice for affect-rich and affect-poor outcomes could be due to differences in outcome comparability, while continuing to look for signs of probability insensitivity. Our first analysis was a manipulation check, testing whether the affect-rich outcomes derived a greater amount of negative affect than the affect-poor outcomes. The primary analysis specifically tested whether the affect gap was still present in our lottery task when affect-rich outcomes were put on an ordinal scale and made more comparable through creating lotteries that involve a choice between the same side effect varying in level of severity. Furthermore, we again explored whether the addition of the icon array has an impact on the presence of the gap, in this case when the affect-rich outcomes are made comparable. In this analysis, we also assessed the potential moderating influence of numeracy. Our final analysis was a comparison of affect-rich outcomes across Studies 1 and 2 (which were simultaneously randomly assigned) to assess the effect of outcome comparability.

Monetary and Affective Evaluation

As was done in Study 1, we began with a manipulation check to ensure that our affect-rich stimuli generated greater negative affect than our affect-poor stimuli. The mean affect ratings are shown for each affect-rich side effect and its affect-poor monetary equivalent in Table 6. We utilized a repeated measures MANOVA to analyze the affect ratings for the affect-rich side effects and the matched affect-poor monetary values. We found a large main effect of affective context, $F(18, 87) = 11.64$, $p < .001$, $n_p^2 = .71$, indicating that our affect-rich outcomes ($M = 6.44$, $SD = 1.06$) were rated as generating significantly more negative affect than the affect-poor monetary equivalents (*M*= 5.05, *SD*= 1.74). Additionally, follow-up univariate analyses demonstrated that with the exception of slight dizziness, each affect-rich side effect elicited a significantly greater amount of negative affect than its affect-poor monetary equivalent.

Also displayed in Table 6 are the 5th, 50th, and 95th percentile responses for the monetary evaluation task to demonstrate the variability in the WTP values. The overall median WTP value in Study 2 was -$15, which was comparable to the overall median of -$10 in Study 1.

Table 6.

Willingness-To-Pay Percentile Values for the Affect-Rich Outcomes, and Mean and Standard Deviations of Affective Ratings for the Affect-Rich Outcomes and Their Affect-Poor Monetary Equivalents in Study 2

				Affect Ratings		
	Willingness-to-pay percentile			Affect-rich outcome	Affect-poor outcome	95% CI of difference
Affect-rich outcome	5%	50%	95%	*M (SD)*	*M (SD)*	*M (SD)*
Slight memory loss	-100	-15	-2	5.21 (2.43)	4.55 (2.62)	[0.09, 1.22]
Moderate memory loss	-500	-25	-6.3	7.29 (1.71)	6.45 (2.43)	[0.37, 1.30]
Severe memory loss	-1000	-50	-10	9.64 (1.00)	8.38 (2.16)	[0.89, 1.63]
Slight hallucinations	-100	-10	0	4.71 (2.41)	4.15 (2.68)	[-0.01, 1.13]
Moderate hallucinations	-167.5	-25	-3.65	6.99 (1.94)	5.97 (2.78)	[0.49, 1.55]
Severe hallucinations	-370	-50	-9.3	9.38 (1.34)	7.78 (2.51)	[1.15, 2.05]
Slight insomnia	-50	-10	0	3.70 (2.21)	3.06 (2.33)	[0.14, 1.15]
Moderate insomnia	-107	-15	-2.65	6.03 (1.95)	4.70 (2.49)	[0.83, 1.83]
Severe insomnia	-200	-30	-6	8.97 (1.88)	6.53 (2.46)	[1.95, 2.93]
Slight dizziness	-50	-7.5	0	3.60 (2.01)	3.08 (2.29)	[0.04, 1.00]
Moderate dizziness	-117.5	-15	-3.65	5.96 (1.84)	4.74 (2.43)	[0.74, 1.70]
Severe dizziness	-235	-30	-6	8.84 (1.56)	6.48 (2.47)	[1.90, 2.82]
Slight fever	-36.75	-5	0	3.38 (1.88)	2.76 (2.08)	[0.18, 1.06]
Moderate fever	-87	-15	-4	5.87 (1.64)	4.38 (2.51)	[1.02, 1.96]
Severe fever	-202.5	-30	-6.65	8.95 (1.60)	6.44 (2.46)	[2.05, 2.97]
Slight fatigue	-25	-5	0	3.04 (1.69)	2.28 (1.93)	[0.36, 1.16]
Moderate fatigue	-50	-10	0	5.74 (1.80)	3.69 (2.25)	[1.60, 2.51]
Severe fatigue	-100	-20	-4.65	8.46 (1.84)	5.49 (2.37)	[2.50, 3.44]

Note. CI = confidence interval. The 95% CIs refer to the difference between the average affect rating for the affect-rich side effects and the average affect rating for the affect-poor willingness-to-pay values. Ratings for the affective evaluation ranged from 1 (not upset) to 10 (very upset).

Lottery Task

As was done in Study 1, we conducted a 2x2x2 Probability Display x Numeracy x Affective Context mixed ANOVA. The results are displayed in Figure 10. The dependent measure for this analysis was the proportion of choices of the higher EV lottery out of a possible 15 to 18 total choices.

Computer error caused one question on the Abbreviated Numeracy Scale to be excluded from analysis (i.e., "If the chance of getting a disease is 20 out of 100, this would be the same as having a _____% chance of getting the disease"). The reliability of this measure without this item was α= .63, indicating adequate reliability. A median split was used to classify groups into low numeracy (i.e., scores of 0-3; N=67) and high numeracy (i.e., scores of 4-7; N=45) for analysis.

Replicating both previous research (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015) and Study 1, we found a significant main effect of affective context, $F(1, 108)= 17.74$, $p< .001$, $n_p^2= .14$, which is displayed in Figure 10. Individuals were more inclined to choose the higher EV lottery in the affect-poor (*M*= 72.25%, *SD*= 15.22%) than in the affect-rich (*M*= 64.19%, *SD*= 14.26%) condition. This supported Hypothesis S2-H1a, and was the only significant effect in the omnibus analysis.

Contrary to our predictions, none of the effects involving probability display were significant ($p > .05$ for all comparisons). Therefore, there was no evidence that viewing the +array condition led to benefits in choice over viewing the numeric condition, or that this was in any way moderated by affective context or numeracy. In particular, we did not find a Probability Display x Affective Context interaction, $F(1, 108) <1$. It appears that the addition of the icon array did not have any influence in either of the affective contexts. These findings are similar to those observed in Study 1, again casting doubt on the hypothesis that poorer performance is due to a lack of attention to probability information.

There was no evidence that performance differed as a function of numeracy ($p > .05$ for all comparisons). In general, the proportion of higher EV choices was similar for individuals high and low in numeracy, and this did not change depending on the affective context or presence of a probability display. Correlations supported this, and demonstrated that there was no relationship between numeracy and choice in the affect-rich ($r(112) = .09$, *ns*) or affect-poor ($r(112) = .17$, *ns*) conditions.

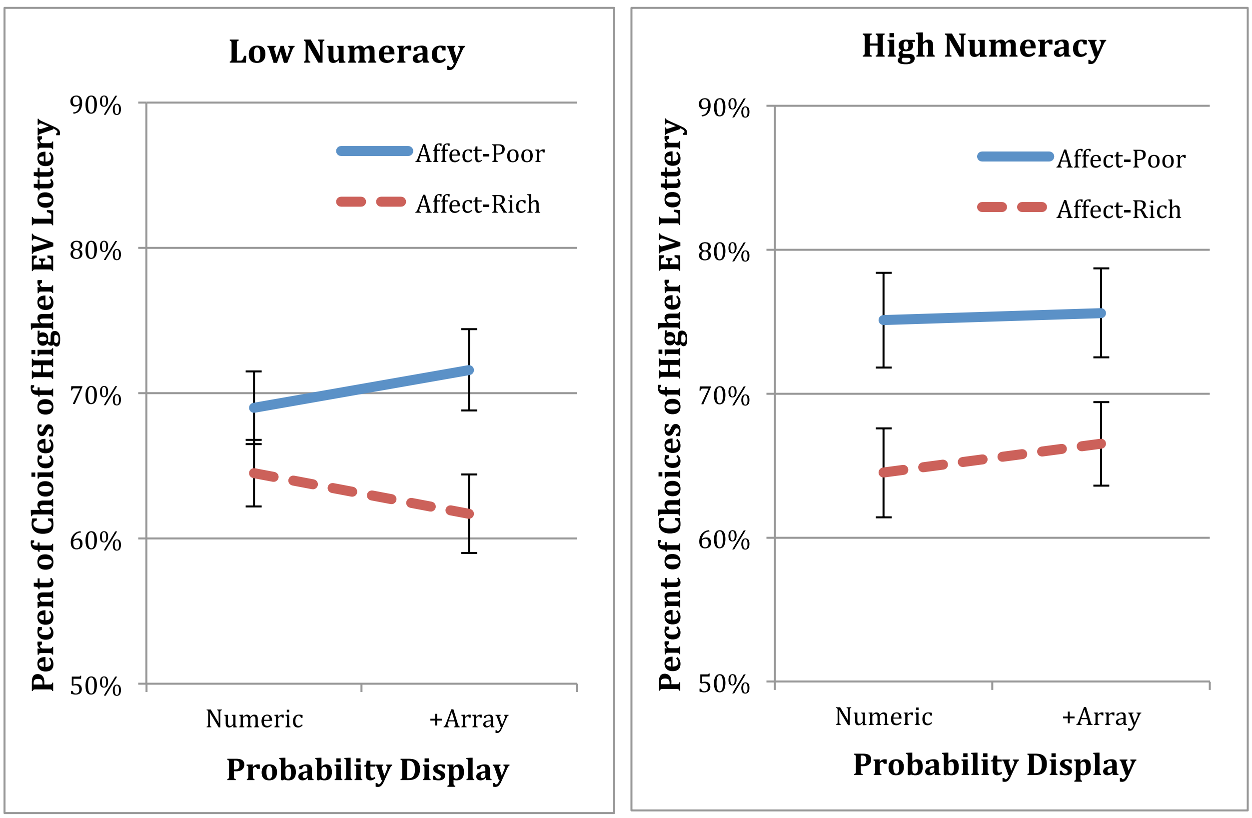


Figure 10. Condition Means for the Probability Display x Numeracy x Affective Context experimental design in Study 2. Note. The three-way interaction was not significant.

In Hypothesis, S2-H1b, we predicted that making the affect-rich outcomes more comparable would reduce the difference in higher EV choices between the affect-rich and affect-poor conditions relative to the difference between the same conditions in Study 1. To test this, we created difference scores from subtracting proportion of choice in the higher EV lottery in the affect-rich context from the affect-poor context for Studies 1 and 2. We then conducted an independent samples t-test of the difference scores from each study. There was no evidence that the average difference in scores between the affective contexts was smaller in Study 2 than Study 1, $t(227) < 1$. Therefore, the aforementioned support for Hypothesis S2-H1a, and the lack of evidence in support of S2-H1b, suggests that differences in choice may not be attributed to a difference in outcome comparability.

Comparability Analysis

We provided a critical test of outcome comparability across studies by examining differences in choice between the affect-rich lotteries only, by comparing the less comparable affect-rich lotteries of Study 1, with the more comparable affect-rich lotteries of Study 2. We conducted a 2x2 Comparability x Probability Display between-subjects ANOVA, which is displayed in Figure 11. Comparability is a between-subjects variable representing whether the outcomes were non-comparable in Study 1 or more comparable in Study 2.

We found a small main effect of comparability, $F(1, 225) = 6.42$, $p = .01$, $n_p^2 = .03$, however, to our surprise, it was in the opposite direction of that predicted by Hypothesis S2-H3. It appears that increasing comparability in Study 2 did not increase the proportion of choices for the higher EV lottery. In fact, individuals were slightly better able to perform this task in Study 1 (*M*= 68.96%, *SD*= 14.22%) when outcomes were less comparable, than in Study 2 (*M*= 64.19%, *SD*= 14.26%), when they were on the same continuum. We were interested in the possibility that this difference may have arisen because WTP values in Study 1 were more spread out across the side effects. This could have lead to larger differences in the EV of the options included in each lottery pair, potentially facilitating choice, as discriminating between the options would be less difficult. To explore this, we assessed the average EV differences for all 18 lotteries using the median WTP values. A t-test demonstrated that there were no differences between Studies 1 and 2 in the average difference in EV between each option in a pair, $t(17) = 1.77$, *ns*. Thus, discrimination of the lottery with the higher EV should not have been any easier in Study 1 than it was in Study 2. This further supports the notion that making outcomes more comparable did not facilitate choice in the affect-rich lotteries.

Neither the main effect of probability display nor the Comparability x Probability Display interaction was significant, $F's\ (1, 225) < 1$. Therefore, contrary to our prediction, choice in the more comparable affect-rich outcomes in Study 2 was not aided more by the addition of the icon array, than choice for the less comparable outcomes of Study 1. This result further supports the notion that the icon array may not be beneficial when working with non-numeric side effect information, even if this information is put on a continuum and described in terms of ordinal differences.

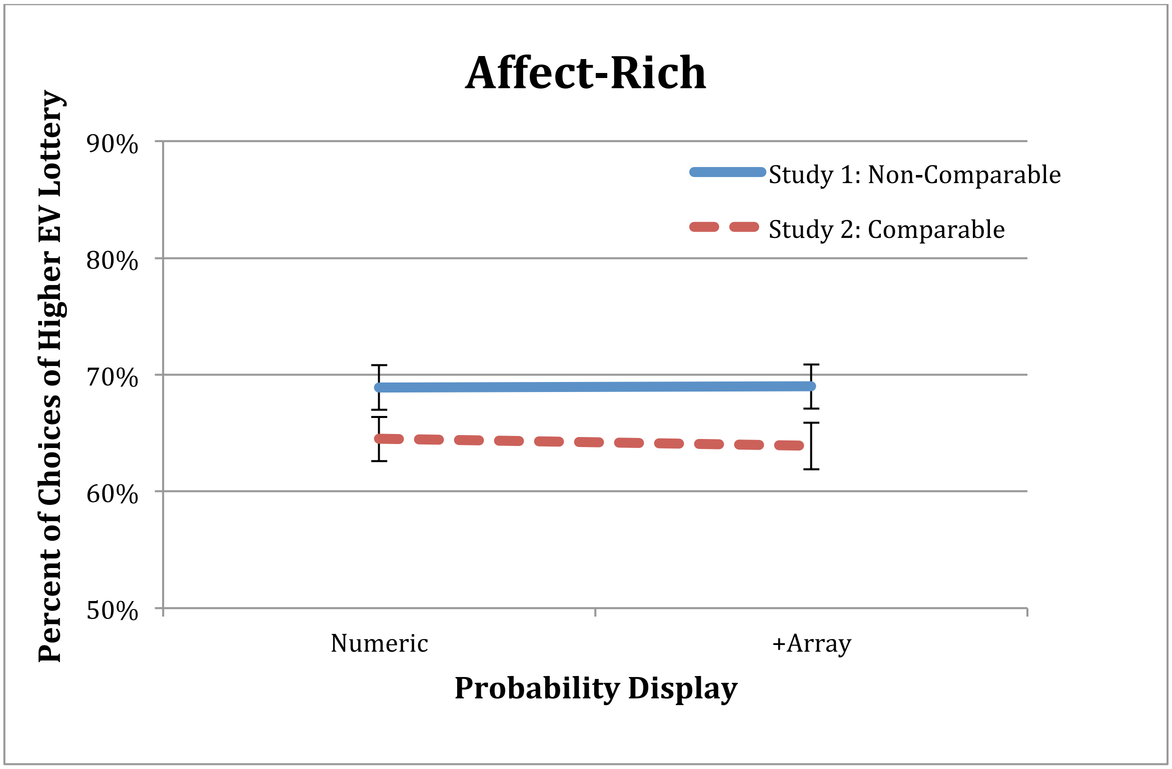


Figure 11. Comparison of choice for the higher EV lottery in the affect-rich context of Studies 1 and 2.

Summary

In Study 2, we again replicated previous findings (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015), demonstrating that individuals were better able to choose the higher EV lottery in an affect-poor than an affect-rich condition. Thus, even when the affect-rich outcomes were put on the same ordered continuum, the differences in the ability to choose the higher EV option remained. Although previous research has demonstrated that it is easier to make comparisons between options that are comparable (Johnson, 1984), we did not find that increasing outcome comparability eliminated the differences in choice between the affect-rich and affect-poor domains. In fact, we found that within the affect-rich context, individuals were actually slightly better at choosing the higher EV lottery when the outcomes were less comparable in Study 1, than when they were more comparable in Study 2.

We again found no evidence that adding the icon array to the numeric probability improved selection of higher EV options, regardless of the affective context. This casts some doubt on the hypothesis that the differences in affect-rich and affect-poor choice are due to probability insensitivity, as was proposed by Pachur and colleagues (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015). If the differences were due to probability insensitivity, we would expect that making the probability information salient in the array would improve choice. However, the lack of benefit seen with the addition of the array in the affect-rich context of both Studies 1 and 2 suggests that probability may not be ignored, but rather, the issue is at the level of integration of this information with the non-numeric side effect outcomes. It appears that even creating an ordinal continuum of side effect information, as was done in Study 2, is not a sufficient substitution for a numeric value when attempting to integrate probability and outcome information.

One potential benefit that was seen by improving comparability was that it allowed individuals varying in numeracy to similarly process the information presented for choice. However, it is possible that this may be due to decreased performance. Overall, the results suggest that outcome comparability does not appear to be a primary contributor in the differences observed in affect-rich and affect-poor choice.

STUDY 3

In Study 3, we examined how the precision of outcomes influenced choice behavior in an affect-rich and affect-poor context. As was done in Study 2, we continued to employ the use of comparisons of the same six side effects varying in severity. However, in Study 3, the affect-poor values were categorized into a range of values and described on an ordered continuum of amounts (e.g. $15-$29 representing a “small” amount of money). The use of a range of numeric values on a continuum introduced a lack of precision similar to the kind of vagueness that is likely to characterize slight, moderate, and severe side effect outcomes. This allows for comparisons of outcomes that are roughly equivalent with regard to level of precision across the affect-rich and affect-poor contexts. In case the numeric component may have still differentiated the two types of outcomes, we also introduced a commonly-used numeric intensity range to accompany the affect-rich outcomes. Thus, if numeric outcomes facilitate integration with probabilities to compute EV, both affect-rich and affect-poor outcomes will have enjoyed the same advantage. Although we did not find strong effects involving Probability Display in Studies 1 or 2, we continued to investigate whether differences in choice would emerge with the addition of an icon array when outcomes were better aligned in terms of precision.

Our hypotheses with respect to the main effect of Probability Display, the Probability Display x Affective Context interaction, the main effect of Numeracy, and the Probability Display x Numeracy interaction were the same as in Study 2.

With respect to the main effect of Affective Context in Study 3, there were competing hypotheses:

S3-H1a: If choice differences were due to probability insensitivity when affect is rich, we expected to see a similar pattern as that predicted in Studies 1 and 2, with a greater proportion of higher EV lotteries chosen in the affect-poor than affect-rich context.

S3-H1b: However, if differences were due to outcome precision, we predicted that the addition of vagueness will reduce the ability of those in the affect-poor conditions to reliably identify the higher EV lottery. Moreover, adding numbers to the affect-rich ranges would also serve to equate the two contexts. Together, this was expected to result in a similar proportion of higher EV lotteries being chosen in the affect-poor and affect-rich contexts. Aligning the level of precision and using numeric values in both contexts should cause the main effect of Affective Context to disappear.

In addition to the hypotheses described above, we provided a stronger assessment of the effect of precision by making a direct comparison across the relatively vague affect-poor lotteries in Study 3 and the precisely defined affect-poor lotteries in Study 2.

S3-H2: If precision facilitated deriving EV, we predicted that individuals would choose a smaller proportion of higher EV lotteries with the vague outcomes in Study 3, than with the precise outcomes in Study 2. However, a Precision x Probability Display interaction could have resulted if introducing vagueness into the outcomes interferes with the ability to properly integrate probability and outcome information, and reduced the usefulness of the icon array.

We also assessed the effect of adding numeric values to severity categories by comparing choices for the affect-rich lotteries in Studies 2 and 3.

S3-H3: If numeric values facilitated deriving EV, individuals would choose a larger proportion of lotteries with the higher EV in Study 3, wherein the affect-rich outcomes have numeric value labels, than in Study 2, wherein they do not have numeric value labels. Additionally, a Numeric

Value x Probability Display interaction could have resulted if introducing the numeric value labels facilitated the ability to properly integrate probability and outcome information, and increased the usefulness of the icon array.

Method

Participants

One hundred twenty-nine participants enrolled in a psychology course at a large urban university were recruited to participate in the study through an online system. They were compensated with extra credit in a psychology course of their choosing. Based on a power analysis, in order to be in a position to find a medium effect size with power = .80 and alpha = .05 when comparing four independent groups, we needed 114 participants. Thirteen participants were eliminated from the data set, leaving 116 participants for analysis.

Similar to Studies 1 and 2, there were trials in which EV may have been equal for both lotteries in a pair. As was done in Studies 1 and 2, any participant with greater than three tied and/or missing trials in each affective context was eliminated. Six were eliminated for having tied/missing data at a threshold of 20% or greater (i.e., having 3 or more tied EV lotteries/missing choices, out of 18, for gamble pairs in each affective context). An additional six participants were eliminated for not following the instructions in the willingness-to-pay task (e.g., indicating the same WTP for all side effects; task described in the procedure), and one was eliminated for computer error in the lottery choice task.

This study was run contemporaneously with Studies 1 and 2, and participants were randomly assigned to one of all possible conditions.

Design

The design did not differ from Studies 1 and 2. The dependent variable remained the proportion of higher EV options chosen out of 18 choices.

Stimuli

The same selection of affect-rich lottery pairs comprised of side effects with categorical qualifiers that was utilized in Study 2 was used as the affect-rich lotteries in Study 3. Additionally, as a way to potentially facilitate EV calculation in the affect-rich context, a range from the numeric 0-10 intensity scale shown in Figure 12 was added to each outcome.

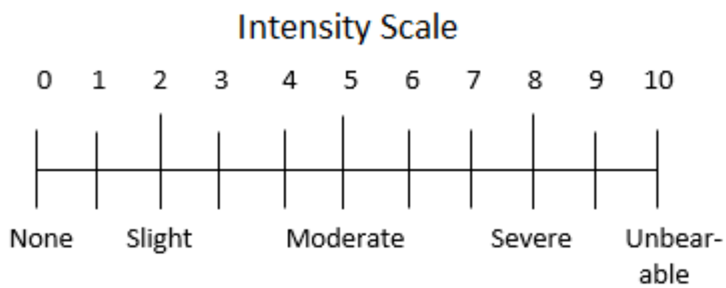


Figure 12. Example intensity scale used with the affect-rich side effects in the WTP task in Study 3.

An example affect-rich numeric lottery pair is shown in Figure 13 on the next page. Outcomes with the categorical qualifier "slight" were associated with intensity values 1-3, "moderate" with values 4-6, and "severe" with values 7-9.

Medication A:

30% chance of **slight insomnia (intensity 1-3)** with
70% chance of no side effect

Medication B:

10% chance of **moderate insomnia (intensity 4-6)** with
90% chance of no side effect

Figure 13. Example affect-rich numeric lottery pair used in Study 3.

The affect-poor stimuli for the lottery task was derived from each participant's WTP value provided in the modified WTP task, described in more detail in the procedure. Affect-poor lotteries utilized the same probabilities as those displayed in the affect-rich context; however, the side effect outcomes were replaced by the WTP value ranges. An example is displayed in Figure 14 below.

Lottery A:
30% chance of losing a **very small amount (under $15)** with
70% chance of losing $0

Lottery B:
10% chance of losing a **small amount ($15-$29)** with
90% chance of losing $0

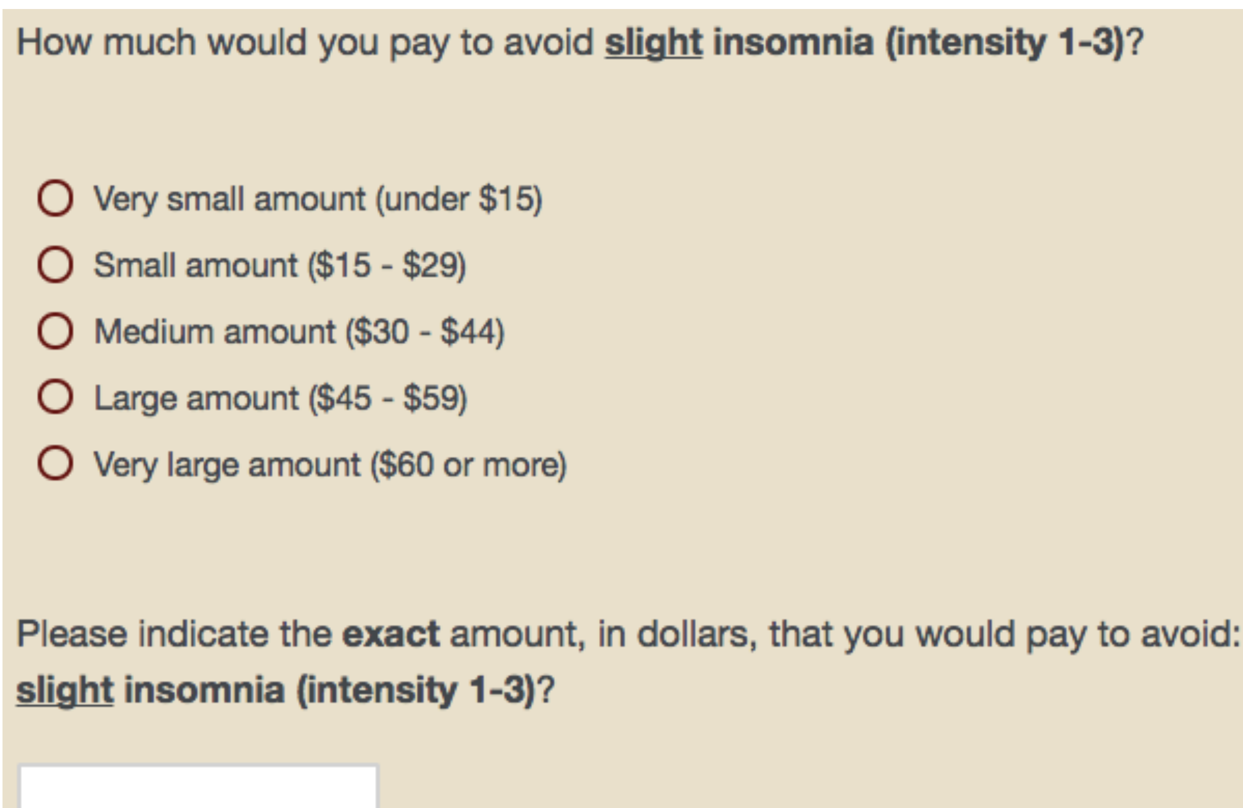
Figure 14. Example affect-poor numeric lottery pair used in Study 3.

The stimuli for the affective evaluation task included the six side effects with categorical qualifiers in addition to the WTP value ranges selected in the monetary evaluation task.

Procedure

The procedure did not differ from Studies 1 and 2, with the exception of the WTP task. In this task, participants viewed each side effect with its severity qualifier, along with a numeric range of discomfort intensity values. Before completing the WTP task, participants viewed the discomfort intensity scale shown in Figure 11. This scale provided a legend to inform participants of the range of numeric intensity values that accompanied each side effect's severity qualifier (e.g., "slight" has a severity intensity range of 1-3). This scale remained visible throughout the WTP task.

Participants were then asked to indicate how much they would be willing to pay to avoid each side effect using a set of five ranges of numeric monetary values. These are shown in Figure 15. The numeric values assigned to each range were created based on the WTP values gathered in the pilot study described previously. Specific values for each range were chosen to minimize the potential that a participant would select the same WTP range for two different severity categories of the same side effect (e.g., slight versus moderate insomnia). As shown in Figure 15, each range of numeric values were also described by a corresponding verbal label: "very small amount," "small amount," "medium amount," "large amount," and "very large amount." After selecting the desired category, the participant indicated the specific WTP value to assist in calculating criterion EVs using the same procedure as in Studies 1 and 2.


How much would you pay to avoid **slight insomnia (intensity 1-3)**?

- Very small amount (under $15)
- Small amount ($15 - $29)
- Medium amount ($30 - $44)
- Large amount ($45 - $59)
- Very large amount ($60 or more)

Please indicate the **exact** amount, in dollars, that you would pay to avoid: **slight insomnia (intensity 1-3)**?

Figure 15. Example questions used in WTP task in Study 3.

Results

In what follows, we assessed whether differences in choice for affect-rich and affect-poor outcomes could be influenced by outcome precision. Our first analysis was again a manipulation check to confirm that the affect-rich outcomes generated more negative affect than the affect-poor outcomes. The primary analysis tested whether the affect gap was still present in our lottery task when affect-poor outcomes were made more vague through the use of numeric value ranges as outcomes. As we have observed little evidence of a difference in choice when utilizing an icon array, we explored whether the array would become beneficial when affect-poor outcomes were made less precise. We also assessed whether choice of the higher EV lottery would differ based on level of numeracy, as was the case in Study 1.

We also completed a cross-study comparison. We began with a test of the role of precision on choice. We compared the precise affect-poor outcomes of Study 2 with the relatively vague outcomes of Study 3 to determine the effect of outcome precision on choice for the higher EV lottery. We expected that making the affect-poor outcomes less precise in Study 3 would lead to a smaller proportion of higher EV lottery choices, compared with choice for the precise affect-poor outcomes of Study 2. Our final test was that of numeric values, in which we make a comparison between the affect-rich outcomes without a numeric value in Study 2, and the affect-rich outcomes with the numeric intensity ranges in Study 3. The goal of this analysis was to determine whether the presence of numeric outcomes in the affect-rich context would facilitate integration with probabilities, leading to a greater proportion of higher EV choices.

Monetary and Affective Evaluation

As was done in Studies 1 and 2, we began with a manipulation check to ensure that our affect-rich stimuli generated greater negative affect than our affect-poor stimuli. In the present Study, the affect-rich stimuli consisted of side effects on a continuum, accompanied by numeric intensity ranges. Comparatively, the affect-poor stimuli were vague numeric ranges. To make this comparison, each side effect needed to have a comparable outcome in the affect-poor condition. However, there were only five affective ratings given for the affect-poor outcomes; one for each of the five numeric outcome ranges. To test the affective ratings of the affect-rich and their matched affect-poor outcomes, we utilized the affective rating associated with a given numeric range, based on the range selected in the WTP task for each side effect. For example, if a participant had specified they would be willing-to-pay under $15 (i.e., range 1) to avoid slight fatigue, we then utilized the affective rating associated with this range (i.e., range 1) as the comparable affect-poor outcome to the affective evaluation given for the affect-rich.

The mean affect ratings are shown for each affect-rich side effect and its affect-poor monetary equivalent in Table 7. We utilized a repeated measures MANOVA to analyze the affect ratings for the affect-rich side effects and the matched affect-poor monetary values. We found a significant main effect of affective context, $F(18, 91)= 6.10$, $p< .001$, $n_p^2 = .55$, indicating that our affect-rich outcomes (*M*= 6.27, *SD*= 1.05) were rated as generating significantly more negative affect than the affect-poor monetary equivalents (*M*= 5.55, *SD*= 1.94). Follow-up univariate analyses demonstrated that the majority of affect-rich side effects elicited a significantly greater amount of negative affect than their affect-poor monetary equivalents. The exceptions to this were slight fatigue, slight fever, slight dizziness, slight insomnia, slight hallucinations, slight memory loss, and moderate memory loss, in which there were no discernible differences between the negative affect generated for the affect-rich and affect-poor equivalents.

Also displayed in Table 7 are the 5th, 50th, and 95th percentile responses for the monetary evaluation task to demonstrate the variability in the exact WTP values that were indicated simultaneously with the category values.

Table 7.

Willingness-To-Pay Percentile Values for the Affect-Rich Outcomes, and Mean and Standard Deviations of Affective Ratings for the Affect-Rich Outcomes and Their Affect-Poor Monetary Equivalents in Study 3

				Affect Ratings		
	Willingness-to-pay percentile			Affect-rich outcome	Affect-poor outcome	95% CI of difference
Affect-rich outcome	5%	50%	95%	*M (SD)*	*M (SD)*	*M (SD)*
Slight memory loss	-104.5	-30	-10	4.98 (2.16)	5.03 (2.61)	[-0.57, 0.47]
Moderate memory loss	-157.5	-45	-15	7.23 (1.79)	6.74 (2.60)	[0.01, 0.98]
Severe memory loss	-272.5	-75	-25	9.66 (0.85)	8.22 (2.32)	[1.06, 1.82]
Slight hallucinations	-83	-29.5	-10	4.76 (2.20)	4.72 (2.60)	[-0.49, 0.57]
Moderate hallucinations	-130	-40	-15	6.57 (1.84)	5.97 (2.59)	[0.11, 1.09]
Severe hallucinations	-200	-60	-24.25	9.11 (1.54)	7.80 (2.33)	[0.88, 1.74]
Slight insomnia	-54.5	-15	-4.7	3.57 (2.04)	3.61 (2.38)	[-0.53, 0.44]
Moderate insomnia	-97.25	-30	-9.7	5.82 (1.95)	4.80 (2.59)	[0.52, 1.52]
Severe insomnia	-153	-48	-15	8.72 (1.80)	6.75 (2.75)	[1.46, 2.48]
Slight dizziness	-51.5	-15	-5	3.41 (2.03)	3.60 (2.28)	[-0.66, 0.28]
Moderate dizziness	-75.75	-27	-10	5.63 (1.84)	4.85 (2.50)	[0.30, 1.26]
Severe dizziness	-150	-50	-14.85	8.55 (1.81)	6.79 (2.72)	[1.26, 2.27]
Slight fever	-62.25	-15	-2.85	3.54 (2.11)	3.70 (2.45)	[-0.66, 0.34]
Moderate fever	-100	-30	-6.7	5.81 (1.92)	5.11 (2.62)	[0.20, 1.20]
Severe fever	-157.5	-50	-15	8.59 (1.80)	7.01 (2.56)	[1.10, 2.06]
Slight fatigue	-56.5	-15	-2	3.03 (2.06)	3.44 (2.36)	[-0.89, 0.07]
Moderate fatigue	-80	-25	-6.7	5.21 (1.89)	4.54 (2.48)	[0.19, 1.15]
Severe fatigue	-131.5	-42	-10	8.09 (1.85)	6.33 (2.72)	[1.25, 2.27]

Note. CI = confidence interval. The 95% CIs refer to the difference between the average affect rating for the affect-rich side effects and the average affect rating for the affect-poor willingness-to-pay values. Ratings for the affective evaluation ranged from 1 (not upset) to 10 (very upset).

Lottery Task

As was done in Study 1 and Study 2, a 2x2x2 Probability Display x Numeracy x Affective Context mixed ANOVA was conducted. The results are displayed in Figure 16. The primary dependent measure was the proportion of choices of the higher EV lottery out of a possible 15 to 18 total choices in each affective context.

We again experience a computer error in which one question on the Abbreviated Numeracy Scale had to be eliminated from analysis (i.e., "If the chance of getting a disease is 20 out of 100, this would be the same as having a _____% chance of getting the disease"). The reliability of this measure without this item was α= .64, indicating adequate reliability. A median split was used to classify groups into low numeracy (i.e., scores of 0-3; N=65) and high numeracy (i.e., scores of 4-7; N=51) for analysis.

In support of our prediction, we found a significant main effect of probability display, $F(1,112)= 8.74$, $p= .004$, $n_p^2= .07$, displayed in Figure 16. We found a greater average proportion of higher EV lottery choices in the +array condition (*M*= 68.69%, *SD*= 13.70%) than the numeric condition (*M*= 61.86%, *SD*= 12.95%). This suggests that the probability display can be beneficial in some cases, particularly when the affect-poor outcomes are vague.

In Hypothesis S3-H1b, we predicted that the main effect of affective context would disappear due to inserting a level of vagueness into the affect-poor outcomes. Consistent with this, there was no main effect of affective context, $F(1,112)= 2.59$, *ns.* Therefore, there was a lack of evidence of a systematic difference in the proportion of choices for the higher EV lottery when viewing the affect-rich lotteries (*M*= 63.59%, *SD*= 19.10%) versus the affect-poor lotteries (*M*= 66.95%, *SD*= 16.75%). Contrary to our prediction, there was no main effect of numeracy, $F(1,112) < 1$, with similar average proportions of higher EV lottery choice for those low (*M*=

65.94%, *SD*= 13.70%) and high (*M*= 65.50%, *SD*= 10.71%) in numeracy. Correlations between numeracy and choice in each affective context did not show a significant relationship (*r*(58)= -.25, *ns* and *r*(58)= -.22, *ns,* for affect-rich and affect-poor numeric condition, respectively, and *r*(58)= .08, *ns* and *r*(58)= .16, *ns* for affect-rich and affect-poor +array condition, respectively).

As was the case in Studies 1 and 2, our Probability Display x Affective Context interaction was not significant, $F(1,112) = 2.81$, *ns*. Thus, the probability insensitivity hypothesis was once again called into question, as we continued to find no evidence in support of this prediction.

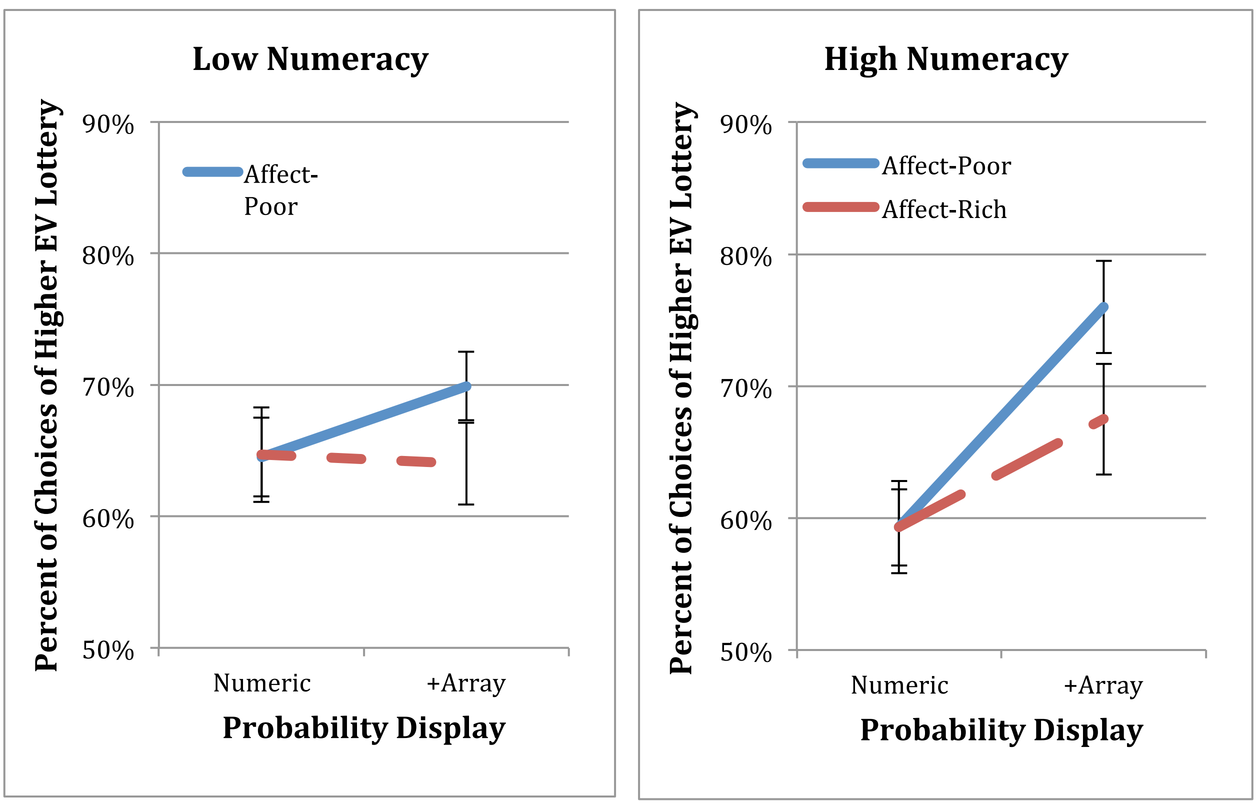


Figure 16. Condition Means for the Probability Display x Numeracy x Affective Context experimental design in Study 3. Note. The three-way interaction was not significant.

As can be seen in Figure 16, we found a significant Probability Display x Numeracy interaction, *F*(1,112)= 4.05, *p*= .05, n_p^2= .04; however, it was not in line with our prediction. We predicted that individuals high in numeracy would choose a greater proportion of higher EV lotteries than those low in numeracy in both the numeric and the icon array conditions, but that individuals low in numeracy would get a larger boost in performance with the addition of the icon array. Instead, we found the opposite pattern, in which individuals high in numeracy received a bigger boost in performance from the addition of the icon array. Simple effects follow-up tests demonstrated that for individuals low in numeracy, there was no evidence of differences across the numeric or +array conditions in average choice rates for the higher EV lottery, *F*(1,112) = 1.04, *ns*. However, for those high in numeracy, choice for the higher EV lottery was greater on average with the icon array than it was without, *F*(1,112)= 10.30, *p*= .002, n_p^2= .08. It is possible that only the high numeracy individuals benefitted from the icon array because those low in numeracy struggled with interpreting the vague outcome information, which made integration with the probability difficult.

Neither the Numeracy x Affective Context nor the Probability Display x Numeracy x Affective Context interaction was significant, *F's*(1,112) <1. Thus, there was little evidence of differences in choice between the affective contexts based on the presence or absence of an icon array.

Test of Precision

We directly examined the effect of precision on choice for the higher EV lottery by making a comparison between the precise affect-poor outcomes of Study 2, and the vague affect-poor outcomes of Study 3. We conducted a 2x2 Precision x Probability Display between-subjects ANOVA, which is displayed in Figure 17. Precision was a between-subjects variable representing whether the affect-poor outcomes were precise (i.e., ratio scale) in Study 2 or vague (i.e., ordinal scale) in Study 3. In line with Hypothesis S3-H2, we found a small, but significant, main effect of precision, $F(1, 224)= 6.68$, $p= .01$, $n_p^2= .03$. Individuals were better able to choose the higher EV lottery on average when the affect-poor outcomes were more precise in Study 2 (*M*= 72.25%, *SD*= 15.22%) than when they were vague in Study 3 (*M*= 66.95%, *SD*= 16.75%). The Precision x Probability Display interaction approached significance, $F(1, 224)= 3.81$, $p= .052$. As this effect was a key prediction, we conducted follow-up tests, which suggested that, when viewing numeric lotteries without the icon array, individuals chose a greater proportion of higher EV lotteries when the affect-poor outcomes were precise (Study 2), than when the affect-poor outcomes were vague (Study 3), $F(1, 224)= 10.58$, $p= .001$, $n_p^2= .05$. However, when the icon array was present, choice of the higher EV lottery was similar for options with precise and vague outcomes, $F(1, 224) <1$. This result suggests that without an accompanying array, vagueness of the affect-poor outcomes of Study 3 hindered individuals' ability to choose the higher EV lottery, compared to choice in the same condition of Study 2. However, with the icon array, individuals' performance in Study 3 was boosted to levels comparable to that seen in the more precise Study 2 affect-poor lotteries.

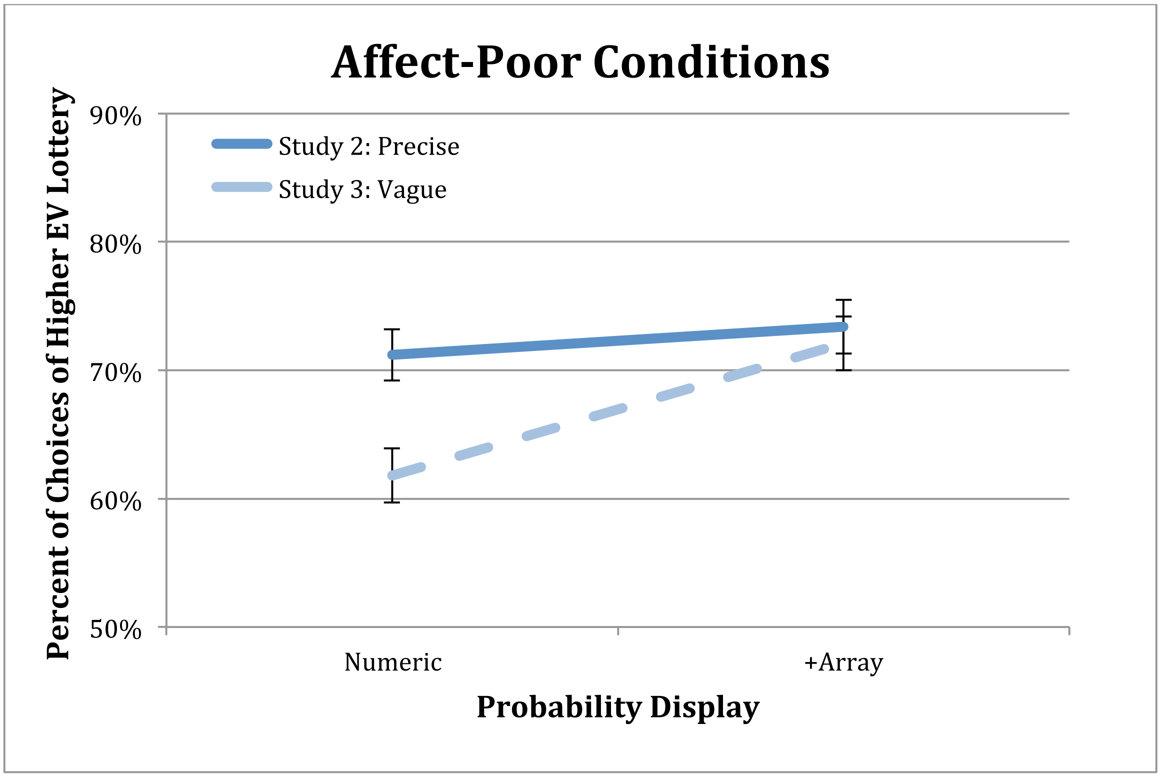


Figure 17. Comparison of choice for the higher EV lottery in the affect-poor context of Studies 2 and 3.

Test of Numeric Intensity Ranges

We also assessed the effect of adding numeric intensity ranges to severity categories by comparing choices for the affect-rich lotteries in Studies 2 and 3. We conducted a 2x2 Numeric Intensity Range x Probability Display between-subjects ANOVA, displayed in Figure 18. Numeric Intensity Range was a between-subjects variable representing whether a range of numeric values was present (Study 3) or absent (Study 2) from the side effect outcomes. Contrary to Hypothesis S3-H3, wherein we predicted that the presence of the numeric intensity range would facilitate choice, the main effect of numeric intensity range was not significant, $F(1, 224) < 1$. Therefore, there was no convincing evidence that adding the numeric intensity range in the affect-rich context of Study 3 lead to better choice than when the range was not present in the affect-rich context of Study 2. We also did not find a significant Numeric Intensity Range x Probability Display interaction, $F(1, 224) < 1$. Therefore, we did not find evidence that introducing the numeric intensity ranges facilitated the ability to properly integrate probability and outcome information, thus it did not increase the usefulness of the icon array.

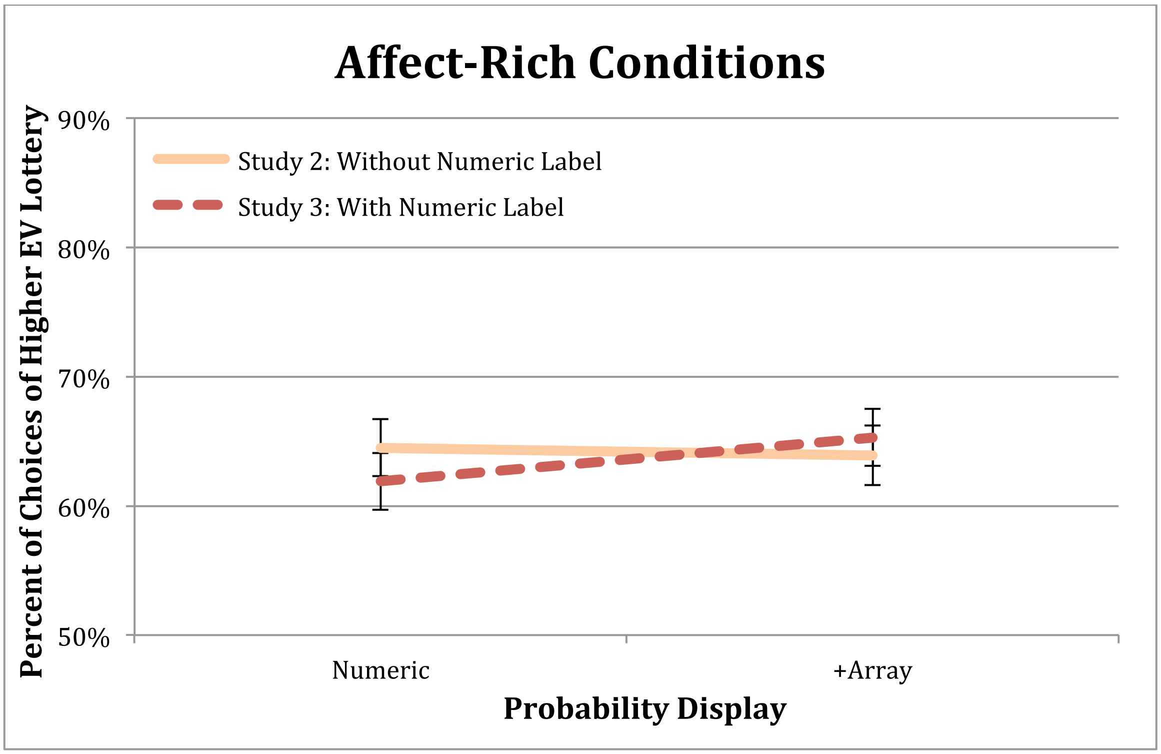


Figure 18. Comparison of choice for the higher EV lottery in the affect-rich context of Studies 2 and 3.

Summary

The results of Study 3 suggest one possible explanation for the differences in affect-rich and affect-poor choice. Specifically, a disparity in outcome precision between the two affective contexts may be leading to the different patterns of choice. In support of our precision hypothesis, we found that making affect-poor outcomes less precise, by displaying ranges of numeric values instead of exact numeric values, eliminated the differences in affect-rich and affect-poor choice, which were seen previously in both Studies 1 and 2. We found further support that precision matters when comparing choice in the affect-poor lotteries for Study 2 and Study 3. Choice was hindered without precise outcomes, at least when an icon array was not available.

The results also suggest that the addition of the icon array may be helpful when affect-poor information is less precise. Furthermore, this facilitation was largely driven by performance of individuals high in numeracy. It is possible that in a vague affect-poor environment, the icon array facilitated attention to and use of probability information. This was likely seen only in individuals high in numeracy because those low in numeracy may have struggled with comprehending the vague outcome information and integrating this with probability. It appears that the addition of the icon array allowed individuals (particularly those high in numeracy) to overcome some of the challenges faced when the affect-poor information was vague.

Finally, we found no evidence that adding numeric intensity ranges to the affect-rich outcomes facilitated choice. It appears that despite the numeric component, the vagueness of the range presents a challenge for integrating probability and outcome information, which further supports our precision hypothesis.

General Discussion

The goal of the present study was to explore potential explanations for the affect gap, originally described by Pachur and colleagues (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015). We investigated whether the differences in choice between affect-rich and affect-poor contexts could be due to probability insensitivity in the presence of affect, and sought to remediate this potential issue with the use of icon arrays. We further explored whether characteristics of outcomes, namely outcome comparability and precision, might be an explanation for the affect gap.

In general, our results replicated Pachur and colleagues, and demonstrated a tendency for performance in the affect-rich side effects to be less than the affect-poor monetary outcomes. However, this only held true when the affect-poor monetary outcomes were more precise than the affect-rich outcomes, suggesting that the affect gap may be related to routine differences in outcome precision across affect-rich and affect-poor outcomes. We found little evidence that the icon array was beneficial in bringing attention to probability, casting doubt on the probability insensitivity hypothesis. There was also no support for the outcome comparability hypothesis. Thus, only a discrepancy in outcome precision remains as a likely alternative to affect as an explanation for the difference in affect-rich and affect-poor choice.

The Influence of Icon Arrays

Utilizing probability displayed as an icon array did not seem beneficial in most cases. Across the three studies, we found no evidence of any benefit when using the icon array in the affect-rich context, despite the prediction that the array would be especially helpful when making choices about side effects if probability insensitivity was an obstacle to choice. Furthermore, there was only an occasional suggestion of benefit for the icon array in the affect-poor context.

In Study 1, there was a suggestion that individuals low in numeracy received some benefit with the addition of the icon array when viewing the monetary outcomes. This finding is consistent with research showing that icon arrays may be especially helpful when low numeracy individuals are working with numerical information (Galesic et al., 2009; Garcia-Retamero & Galesic, 2010). However, this benefit did not extend to those who were high in numeracy. We found no benefit of the icon array in Study 2 for either high or low numerates, which suggests that making the side effect outcomes more comparable to one another did not facilitate the use of this visual aid.

One context in which the array was advantageous was with the vague monetary outcomes in Study 3. We found that adding the array to the vague affect-poor information boosted choice quality to the same level as it had been for the precise affect-poor outcomes in Study 2. This finding seems to be driven by the choice of high numeracy individuals in this affect-poor condition. We did not observe the same benefit for those low in numeracy, as we did in Study 1, although the effect was in the correct direction. It is possible that making the affect-poor information vague created an especially problematic situation for those low in numeracy, whereas individuals high in numeracy were more equipped to integrate the visual probability information depicted in the icon array. This is in line with the idea that low numeracy individuals less frequently incorporate multiple pieces of information in their decision (cf. Peters et al., 2006). It would be reasonable to suggest that this is especially so when there is added difficulty processing vague information. This is also supported by research demonstrating that individuals high in numeracy have a superior understanding of numeric information and utilize it more frequently in their decisions (Peters & Levin, 2008). Furthermore, they are better able to work with complex numeric information and utilize it in preference construction (Peters & Levin, 2008). The added complexity of the vague monetary outcomes may have been have been challenging, but the high numerates were able to overcome this when probability was presented visually in the icon array.

Overall, it appears that it is only when deciding about monetary outcomes that any benefits of the icon array were observed. Comparatively, when making a choice between affect-rich side effects, drawing attention to probability through the use of an icon array did not facilitate choice. One possibility for why we did not find benefits with the affect-rich side effects involves potential problems with the integration of probability and qualitative outcome information. While combining two numbers (i.e., probability and monetary outcome) is straightforward, attempting to combine a number with a side effect is more challenging. For example, McGraw and colleagues (2010) discuss how non-monetary (and non-numeric) outcomes do not instinctively elicit a numeric valuation, and how this becomes problematic when attempting to combine this non-numeric component with probability. In order to appropriately integrate the probability and outcome information, the non-numeric valuations must be transformed into a monetary or numeric figure. It is plausible that in the affect-rich context individuals are aware of the probability information, but they are unable to integrate it appropriately with the non-numeric outcome information of potential drug side effects.

The general lack of additional effects involving the probability display might also be related to the high levels of performance, even without the icon array. We found that when utilizing just the numeric probability, individuals on average chose the higher EV lottery in 77% and 71% of cases in Studies 1and 2, respectively. Even in the affect-rich condition, performance was relatively high, with choice for the higher EV lottery at 69% in Study 1 and 65% in Study 2. In general, these rates are much higher than those found in the numeric conditions of research utilizing icon arrays, which, on average, is closer to 50% without an aid (Galesic et al. 2009; Garcia-Retamero & Galesic, 2010; Hawley et al., 2008; Waters et al., 2007). Comparatively, with the probability array, choice for the better lottery in the affect-poor condition was 80% and 73% in Studies 1 and 2, respectively. Performance in the affect-rich condition with the array was also good, at 69% for Study 1 and 64% for Study 2.These rates are similar to those found in other risk research when using similar probability aids, with averages around 70% (Galesic et al. 2009; Garcia-Retamero & Galesic, 2010; Hawley et al., 2008; Waters et al., 2007).

Given that performance was already good without the array, it is possible that the addition of the icon array did not lead to further improvements because individuals did not need the array to further draw their attention to, or help them process, the probability information being presented when outcomes were precise. However, when outcomes were vague, individuals may have relied more on the visual probability, as there may have been an increased focus on processing the vague outcomes and increased difficulty integrating the vague monetary outcomes with the probability information.

The question remains as to why performance was as good as it was, even without a visual aid for probability information. In the present study, we made multiple enhancements to the presentation of stimuli in all conditions that may account for the higher levels of performance. First, we used fewer words to present the probability and outcome information, which simplified the information to be processed. Previous research has shown, particularly in a medical context, that presenting fewer words leads to increased comprehension of instructions (Jolly, Scott, & Sanford, 1995). This is also in line with the idea that "less is more," in which choice is aided by presenting only the most important information (Peters, Dieckmann, Dixon, Hibbard, & Mertz, 2007). We also increased the overall size of the stimuli, while placing further emphasis specifically on the probability and outcome by bolding both pieces of information, and making them larger than the surrounding text. Peters and colleagues (2007) demonstrated how highlighting the most important information to be used increased both comprehension and quality of choice over information that was not highlighted. In the present series of studies, highlighting the probability and outcome information may have helped make the most relevant pieces salient, which resulted in better choice (Peters et al., 2007).

A final possibility is that the icon array manipulation may not have been strong enough, thus, the probability displays could have been inefficacious. However, this seems unlikely, especially given the effects observed in Study 3. We developed our icon arrays to be similar to those used previously in risk research; therefore, we expected that they would provide benefit. For example, following Hawley and colleagues (2008) and Garcia-Retamero and Galesic (2010), our displays used 10 x 10 square grids of 100 total icons. By using circles filled in with an "X" to represent probability of non-zero outcomes, we combined the methods used previously by Galesic and colleagues (2009), Garcia-Retamero and colleagues (2010), Garcia-Retamero and Galesic (2010), and Waters and colleagues (2007). These authors used circles that were completely filled with black (Galesic et al., 2009; Garcia-Retamero et al. 2010; Garcia-Retamero & Galesic, 2010) or rectangles than encased a shape (Waters et al., 2007). Thus, our icon arrays, though displaying slight differences, shared similar properties to other displays that have been effective in previous research.

On review, we identified one potentially important difference between the much of the research using icon arrays and the current research. Specifically, previous tasks have utilized the displays in a paradigm in which an individual must calculate the risk reduction associated with a given treatment. In this paradigm, individuals are often given two arrays, which accompany the numeric information, and compare the risk of the same disease with and without treatment. Comparatively, the paradigm used in the present research utilizes different outcome information for each option and requires an integration of this with probability. Therefore, it is possible that we found little evidence for the use of an icon array because previous paradigms have used the array to represent a change of likelihood in single event, whereas we used arrays to depict independent probabilities that have to be integrated with two different outcomes.

In sum, our results cast doubt on the probability insensitivity explanation as was put forth by Pachur and colleagues (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015). In their interpretation of probability insensitivity, the authors' focus primarily on probability neglect or discounting as the cause of differences in affect-rich and affect-poor choice. However, our results suggest that it may not be that individuals aren't paying attention to probability, but rather they have difficulty integrating this information with outcomes. Pachur and colleagues (2014) make a small acknowledgement to this idea, and the present series of studies lends more weight to the possibility that it is integration rather than attention.

Differences in Affect-Rich and Affect-Poor Choice

Outcome Comparability.

One primary difference between the affect-rich side effects and affect-poor monetary outcomes used by Pachur and colleagues (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015) exists at the level of comparability between the outcomes used in choice. In the affect-poor context, comparisons were made between two monetary amounts, which share the same attributes and exist on the same continuum. However, in the affect-rich context, comparisons were made between two side effects that likely do not share the same attributes and do not represent a single continuum. Research has demonstrated that options with noncomparable attributes (Johnson, 1984) are more difficult to compare because the differences inherent to these options do not align on the same scales. We hypothesized that this difference in alignability, or outcome comparability, could account for the differences in affect-rich and affect-poor choice. If this hypothesis were correct, making the affect-rich outcomes more comparable, by utilizing choices between options involving the same side effect varying in level of severity, should have improved choice accuracy relative to affective contexts comparing different side effects, and should have eliminated or at least reduced the differences in choice accuracy between the affect-rich and affect-poor choice sets.

Contrary to our predictions, we did not find evidence that differences in affect-rich and affect-poor choice could be attributed to fundamental differences in the comparability of outcomes within choice pairs. Even when making comparisons between side effects representing the same continuum (e.g., slight insomnia versus moderate insomnia rather than insomnia versus dizziness), the pattern of findings of Pachur and colleagues remained unchanged. Choice among affect-rich side effects was not facilitated by making outcomes more comparable to one another.

Overall, we did not observe any benefit when having participants make decisions between the same side effect that varied in intensity. Although the outcomes were described on an ordered scale from slight to moderate to severe, individuals did not seem to treat them as though they existed on a numeric scale (or on whatever level scale would be needed) in order to effectively integrate this information with probability. Without this quantitative valuation of the outcome, the combination with probability may be hindered.

Outcome Precision.

Another component of outcomes that differs in the affect-rich and affect-poor contexts used previously by Pachur and colleagues (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015) is the degree to which the outcomes describe a precise amount. The affect-poor outcomes used were exact numeric values, while the affect-rich outcomes were names of side effects, which did not specify specific amounts or intensities. In Study 3, we attempted to remove the advantage of precise outcomes from the affect-poor context by using numeric ranges as the affect-poor monetary outcomes (e.g., a small amount, $15-$29). In this way, both the affect-rich and the affect-poor contexts shared a similar level of vagueness. If affect-rich choices are hampered by the vagueness of outcomes such as side effects, we expected that introducing vagueness into the monetary outcomes would decrease choice quality, eliminating or reducing the differences in affect-rich and affect-poor contexts seen previously by Pachur and colleagues.

As predicted, when monetary outcomes were described in less precise terms using numeric ranges the difference in affect-rich and affect-poor choice disappeared in the standard choice format. This resulted because of a drop in performance in the numeric condition of the affect-poor lotteries. Furthermore, there was a noticeable difference in performance in the numeric conditions of Studies 2 and 3, with choice for the more vague affect-poor outcomes in Study 3 falling below that of the precise affect-poor outcomes in Study 2. Therefore, when the information was more vague, and the probability was only displayed numerically, individuals' choice suffered.

When using the precise monetary values, as was done in Studies 1 and 2, there are few obstacles to integrating probability and outcome information, because both share a similar scale and the same attributes, with quantitative amounts depicted in exact terms. Furthermore, it is relatively straightforward to combine these precise outcome values with the probability information presented. However, it appears that the integration of the outcome and probability information became more difficult in Study 3 when vagueness was introduced and an array was not available. Research has demonstrated that integrating probability and outcomes is more complex when working with less precise nonmonetary outcomes (McGraw et al., 2010). As the vagueness present in the affect-poor outcomes was intended to be similar to that inherent in the affect-rich, it is likely that the difficulty with integration observed for the side effects may have carried over into the vague monetary outcomes.

One reason that integration of probability and outcome information is so difficult with non-numeric outcomes is because individuals do not intuitively assign a numeric monetary value to a non-numeric outcome (McGraw et al. 2010; Nunes & Park, 2003). For example, Nunes and Park (2003) used a paradigm based on Kahneman and Tversky's (1984) calculator-jacket problem. In the standard version, participants were asked about their willingness to travel 15 minutes to save $10 on a $25 item or to travel the same distance for the same savings on a $125 item. They found a greater tendency for individuals to travel to save the $10 on the $25 item than the $125 item. However, when the $10 savings was replaced by a gift umbrella (a non-monetary outcome estimated to have a $10 value), the effect disappeared. Thus, it appears that individuals did not intuitively translate the perceived worth of the umbrella into its monetary value before choice; if this were the case, the original effect would likely have been replicated.

Nunes and Park (2003) define situations such as this as having incommensurate resources, in which something of value cannot be straightforwardly converted into a single currency or common unit of measurement. If individuals do not automatically assign a numeric monetary value to a non-numeric outcome, the ability to integrate this non-numeric outcome with relevant probability information is difficult (McGraw et al. 2010). As the affect-poor outcomes of Study 3 share a level of vagueness inherent in many non-numeric outcomes, it is reasonable to suggest that the difficulties seen with combining probability and outcome information in a vague non-numeric context could also transfer over to this vague numeric context. Thus, by using vague outcomes in the affect-poor context, we created a situation that mimicked the affect-rich, in which integration of the probability and outcome information was challenging. It is reasonable to suggest that this lead to an elimination of the differences previously observed in affect-rich and affect-poor choice.

Theoretical Implications and Applications

Though Pachur and colleagues'(Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015) previously considered preferences in each affective context to be related to affect's ability to serve "as a spotlight," (see Peters, 2006), or act "as information," (see Schwartz & Clore, 1983), differences in choice based on affective context can also be considered with respect to a dual-systems framework. Dual-systems or dual-types (Evans & Stanovich, 2013) approaches posit that there are distinct cognitive systems that are utilized in decision-making. System 1 is often classified as automatic or heuristic, fast, and deals with basic emotions, whereas System 2 is deliberative, controlled, slow, and analytic (Evans & Stanovich, 2013). Using this system classification, affect-rich decisions are typically seen as falling under System 1 control, whereas affect-poor are more often associated with System 2.

However, it appears that System 1 versus 2 control becomes less distinct when the affect-poor outcomes are made less precise. It is possible that in the absence of precision, the analytic processes central to System 2 are challenged. When deliberate, analytical, processes cannot be used, decision making may then be left to be controlled by the more-heuristic System 1. Although affect-based decisions routinely fall under System 1 processing, here we see the possibility that System 1 may also intervene when less affective information is not precise.

We are often in situations in which we must make decisions between things that involve some level of affect, and these decisions are frequently about things that are not precise. For example, options may not be especially precise when deciding on which restaurant to visit for dinner, which model car to buy, or where to go on vacation. In the present research, we found that decision making when affect is involved is not just about the feeling state, but that may also be impacted by a lack of precision present in the decision context. Therefore, in all of these examples, it is important to learn how lack of precision, versus feelings states per se, may influence which strategies are employed to make a decision, and which preferences result.

Limitations and Future Directions

This research presents initial evidence of a possible explanation for the affect gap described by Pachur and colleagues (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015). Pachur and colleagues attribute differences in affect-rich and affect-poor choice to probability insensitivity, which results from the feeling states triggered with stronger affective outcomes. However, we observed that there are other components to these affect-rich outcomes that help explain the differences observed, namely, outcome precision.

In the present research, we demonstrated that affect-poor performance can deteriorate when the outcomes are made to be similar to the affect-rich, by inserting vagueness. However, whether the differences in affect-rich and affect-poor choice can continue to be eliminated when the affect-rich outcomes are more precise remains to be seen. One benefit to exploring decision making when both affective contexts are precise, is that it would further clarify whether differences in choice could be due to issues with integration of probability and outcome information. In this test, any difficulty with integration of probability and outcome information would presumably be eliminated, as the outcome would be both precise and numeric in both affective contexts.

One way in which this could be assessed, is by utilizing an affective stimulus that incorporates exact numeric values as the affect-rich outcomes, for example, those associated with pain. We would expect that if integration was an issue underlying the differences in choice in each affective context, making the affect-rich outcome information exact would raise choice in this context to be similar to levels of the affect-poor.

This test of precision would also help to isolate the affect present in the affect-rich outcomes and make it less different from monetary outcomes, but it may not eliminate all the non-emotional differences between the outcomes. Working to eliminate these differences would further elucidate whether the presence of the feeling states of affect could account for the differences in affect-rich and affect-poor choice when other components inherent in affect are held constant (e.g., precision). Future research must continue to try and isolate the emotional component so that findings are not misattributed to the feeling states of affect, when it is plausible that it could be another component, such as vagueness.

In our study, we made the affect-poor outcomes less precise, in an attempt to better match the vagueness that characterized the affect-rich outcomes. With respect to the side effects, they are inherently vague or fuzzy, as they do not have specific borders or boundaries (Naess & Gullvag, 1996). However, working with the less precise numerical values still allowed for boundaries to be known (e.g. $15-$29 has a definite starting and ending amount), perhaps making them ambiguous rather than inherently vague. Therefore, it appears that there is still a fundamental difference in working with numerical and non-numerical information, even when trying to match them in terms of vagueness. To help correct this, we utilized finite ranges in the affect-rich side effects by incorporating the intensity scale. However, future research may benefit from a focus on what it means to be working with less precise information and how this information may differ in terms of constructs such as vagueness or ambiguity.

The present research focused on outcomes in the negative domain; however research has found the affect gap in both the negative and positive domains (Pachur et al., 2014). Specifically, Pachur and colleagues (2014) found that individuals' choice was worse when comparing affect-rich hotel amenities than affect-poor monetary outcomes. It would be worthwhile to explore whether manipulating outcome precision in the affect-poor context would also lead to an elimination of the affect gap in the positive domain. If a discrepancy in outcome precision is an underlying explanation for the affect gap, we expect that this result would generalize across domains.

Finally, we utilized a college sample, which demonstrates that differences in affect-rich and affect-poor choice can be replicated in a highly educated sample from the United States. Our results further show that the differences in choice seen previously in the general population of the United States and Germany (Pachur & Galesic, 2012), and in a college population in Switzerland (Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015), can be eliminated by decreasing affect-poor outcome precision. The use of a college population is ubiquitous in psychological research; however it is important to determine whether this finding is robust and would generalize to the original populations used in this line of research, as well as other populations of interest. The inability to generalize would suggest that the capacity to eliminate differences in choice is limited to a very specific population, namely, highly educated individuals in the United States. We do not expect this would be the case.

Conclusion

Affect is ubiquitous in daily life and many decisions that we make involve affect in some form. Though affect is most commonly thought of as feeling states, outcomes rich with affect are multidimensional. In the present research, we examined some of these dimensions as potential causes underlying differences in choice for affect-rich and affect-poor outcomes. We explored the possibility that differences were due to probability insensitivity, and if so, attempted to correct this problem by making likelihoods salient in an icon array. However, we also investigated an alternative explanation, namely, that differences exist because of characteristics inherent in the outcomes themselves: the outcome comparability and/or outcome precision. Our results provided initial evidence for an alternative explanation to that provided by Pachur and colleagues (Pachur & Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015) for the affect gap, specifically, that differences exist due to an imbalance in the outcome precision that exists in affect-rich and affect-poor choice.

It appears that it is difficult to choose well when the outcome information is vague, which is potentially the result of a challenge integrating probability with the outcome. However, this does not rule out the possibility that the feeling state of affect isn't involved in the discrepancies between affect-rich and affect-poor choice. Though affect has been deemed integral in guiding choice (Damasio, 1994) there may be any number of ways in which affect can influence our decisions. As was demonstrated here, these may go beyond the feelings themselves to include other characteristics, such as their qualitative and imprecise nature. This research is a first step in providing a viable explanation for the affect gap found by Pachur and colleagues (Pachur &

Galesic, 2012; Pachur et al., 2014; Suter, Pachur, & Hertwig, 2015) and contributes to our understanding of how and why affect-rich and affect-poor choice may differ.

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