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Unpacking Unpacking: Greater Detail Can Reduce Perceived Likelihood

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Past research suggests that a categorical event is perceived to be more likely if its subcases are explicitly delineated or "unpacked." In 6 studies, we find that unpacking can often make an event seem less likely, especially when the details being unpacked are already highly accessible. Process evidence shows that the provision of greater detail accompanying unpacking reduces the simplicity of an event and that this dysfluency is used as a negative cue for likelihood. This work establishes processing fluency as a mechanism that opposes the other effects of unpacking, such as enhanced accessibility.

Keywords: unpacking, fluency, likelihood

Events can be decomposed in various ways. For example, the category of unnatural deaths can be separated into deaths from automobile accidents, drowning, electrocution, suffocation, hypothermia, hyperthermia, poisoning, homicide, suicide, and attacks from various kinds of animals (including bees, scorpions, spiders, sharks, grizzly bears, and mountain lions). A baseball batter can reach base safely by getting a hit, drawing a walk, getting hit by a pitch, hitting into a fielder's choice, fielder error, catcher interference, or a dropped third strike. A red playing card can be a heart or a diamond.

Past research suggests that an event is generally perceived to be more likely if its categorical elements are explicitly delineated or "unpacked" as in the previously described examples. For example, Stanford undergraduates attributed 32% of all deaths to "unnatural causes" when that category was left packed, but 53% of all deaths when that category was unpacked as "accidents, homicides, or other unnatural causes" (Tversky & Koehler, 1994). Some unpacking experiments demonstrate *explicit subadditivity*, whereby the sum of separate probability judgments of mutually exclusive constituents exceeds the judgment for the superordinate category (Brenner & Rottenstreich, 1999; Fischhoff, Slovic, & Lichtenstein, 1978; Fox & Tversky, 1998; Mulford & Dawes, 1999; Rottenstreich & Tversky, 1997; Wright & Whalley, 1983). Other experiments have demonstrated *implicit subadditivity*, in which a single probability judgment of a superordinate event is greater when the subcases are explicitly listed (Fox & Tversky, 1998; Koehler, 2000; Tversky & Koehler, 1994). Summarizing both types of subadditivity, Tversky and Koehler (1994) remarked, "[L]ike the measured length of a coastline, which increases as a map becomes more detailed, the perceived likelihood of an event increases as its description becomes more specific" (p. 565).

In the present research, however, we document several instances in which greater detail reduces subjective likelihood. For example, a gamble involving the roll of a die is judged to be less attractive if the winning event is unpacked ("rolling a 2, 4, or 6") than when it is not ("rolling an even number"). We propose that unpacking an event provides additional details that reduce how readily it is interpreted and that this dysfluency makes the occurrence of the event seem less likely. The greater complexity does not prevent comprehension (indeed, people are quite accurate in estimating the probability of the previously described unpacked event), but it does increase the effort required to comprehend the event.

The premise that respondents intuitively equate simplicity with likelihood accords with other research showing that more fluent stimuli are judged to be more frequent and believable (see Alter & Oppenheimer, 2009; Schwarz, 2004, for reviews). In fact, a relationship between simplicity and likelihood seems to be quite automatic and well ingrained. We have found evidence, using an implicit association test (Greenwald, Nosek, & Banaji, 2003), that people naturally associate the concept of likeliness more with simplicity than with complexity.[1] People seem to believe that simpler equals more likely, and they rely on this naïve theory to interpret feelings of fluency (Unkelbach, 2006). This inference likely has some real-world validity as additional stipulations – as, say, in a contract – diminish the likelihood that they will be collectively fulfilled.

By showing how fluency can moderate and even reverse the usual effects of unpacking, our work joins two literatures not typically considered together. We contend that the fluency effect we document also occurs in other unpacking studies but is overwhelmed by other, opposing effects of unpacking manipulations. In our research, we intentionally select psychologically impoverished categories (such as the outcome of a die roll) whose subcases or *disjuncts* are few, obvious, equally typical, and readily enumerated. This setting limits other effects of unpacking and helps

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[1] We asked participants (n = 386) to categorize words related to the notion of simple (e.g., basic) versus complex (e.g., elaborate) and likely (e.g., probable) versus unlikely (e.g., doubtful). They categorized them faster when "simple" and "likely" shared the same response key (M = 1.07 s) than when "complex" and "likely" did (M = 1.48 s). This difference was significant when analyzed with the raw means, Δ = 414 ms, $t(385)$ = 24.57, $p < .0001$, or standardized individual-level z scores, z = 0.72, $t(385)$ = 29.89, $p < .0001$.

isolate the effect of fluency. For example, we doubt that in the domain of rolling a die, unpacking an even number as a 2, a 4, or a 6 reminds respondents of an outcome they would otherwise neglect or changes their construal of a category in the same way that unpacking unnatural deaths reminds respondents that suicides are part of that category.

Though we propose a distinct mechanism, we are not the first to document counterexamples to the typical finding that unpacked descriptions are judged to be more likely. Sloman, Wisniewski, Rottenstreich, Hadjichristidis, and Fox (2004) found that support for a focal event can be reduced by calling attention to rare or highly atypical exemplars. For example, in their studies, death from "pneumonia, diabetes, cirrhosis, or any other disease" was judged to be less likely than dying from "a disease." The presented examples not only consume respondents' attention and working memory that might otherwise be used to summon more common diseases to mind (Dougherty & Hunter, 2003), they may even change respondents' construal of the types of ailments or conditions that qualify as a disease. By contrast, unpacking likely has little effect on the perceived extension or definition of the category for the focal events in our research (e.g., the outcome of a die roll). As we discuss later, this is evidenced by the minimal effects of our unpacking manipulations on "mathematical" measures of probability.

Other results that depart from the typical unpacking findings are those showing that support for the focal event can be increased by unpacking that event's complement. For example, respondents rated the likelihood of selecting a chocolate chip cookie to be higher if the remaining cookies in the jar were unpacked into an even mixture of other flavors (i.e., many weak alternatives) than if most of the other cookies were only a single flavor (i.e., one strong alternative). This *alternative–outcomes effect* (Windschitl & Wells, 1998) is thought to occur because the focal event is disproportionately affected by comparisons to the most likely alternative that such manipulations alter. In contrast with those studies, we manipulated descriptions of the focal event, not the alternative event. Moreover, the unpacking manipulations in our studies did not influence support for alternative outcomes, which were all equally typical and were equally probable.

We demonstrate unpacking reversals in six studies and provide support for our theoretical account. Studies 1–3 show that if the description of the winning event is unpacked, the gamble is less preferred and is judged to be less likely on subjective scales. This effect is larger when the unpacked description cannot readily be "repacked" into a superordinate category. Study 4 weighs against several alternative explanations by showing that the effect reverses in the domain of losses. Study 5 shows that the effect remains when the alternative outcomes are explicitly stated, and also provides initial process evidence. Mediation analyses in Study 6 provide further evidence that unpacking decreases perceived simplicity and that this subsequently reduces confidence in the occurrence of the focal event and the attractiveness of gambles whose payoffs are contingent on their occurrence.

Study 1

Method

Seventy undergraduates participated in exchange for course credit. All participants encountered three versions of a gamble presented in a random order and embedded among other unrelated gambles.[2] The focal gamble ("Roll a six-sided die twice and win $50 if [event]") was described in one of three ways: (a) "if you get a 4 on either roll" (packed version), (b) "if you get a 4 on the first roll or a 4 on the second roll" (unpacked version), or (c) "if you get a 2 on the first roll or a 4 on the second roll" (unpacked unmatched version). Our dependent variable was the strength of preference for the described gamble vis à vis a smaller sure amount of $9, which respondents indicated on a scale ranging from 0 (*strong preference for the sure thing*) to 10 (*strong preference for the gamble*), with 5 indicating indifference. We predicted that the packed version would be the most preferred because it was the easiest to understand, while the unmatched unpacked version would be the least preferred because it was the hardest to understand.

Results and Discussion

Table 1 shows the means for each gamble in this study (and all subsequent studies). Participants preferred the packed version ($M = 5.4$) more than the two unpacked versions (pooled $M = 3.5$), $t(69) = 7.16$, $p < .0001$, $\eta^2 = .34$. If analyzed at the individual level, the data indicate the same pattern: 61% of the participants rated the simpler gamble as more attractive than the mean of the unpacked versions, compared with just 20% showing the opposite pattern, $\chi^2(1) = 14.95$, $p < .0001$.

Among the unpacked gambles, the matched version was preferred to the unmatched version ($M = 4.0$ vs. $M = 3.0$), $t(69) = 4.31$, $p < .0001$. We attribute this to the fact that a 4 on the first or second roll is more readily repacked into the simpler description. The fact that the two unpacked versions differed suggests that these effects were not due to lower motivation to process a longer description. Rather, the underlying simplicity of a gamble appeared to affect preference and, presumably, perceptions of likelihood.

Study 2

In the foregoing study, respondents may have had a rough idea of the probability of winning but probably did not compute the exact chances (11/36). In this study, we tested whether the complexity associated with unpacking could reduce the attractiveness of a gamble even when the objective probability was easily computed.

Method

One hundred and fifty-one undergraduates completed this study in exchange for course credit. Everyone saw three versions of a gamble that involved the opportunity to "roll a six-sided die and win $50 if [event]." The event was described as (a) "getting an even number," (b) "getting a 2, 4, or 6," or (c) "getting a 1, 4, or 6." These three gambles were presented in random order amid other unrelated gambles. The principal dependent variable was a stated strength of preference for or against the focal gamble when the alternative was a sure $15. Respondents reported this on the

[2] The following is an example of a filler gamble: "Pick a person out of a group of 10 people and win $70 if that person was born on a Saturday or Sunday."

Table 1
Mean Results in Studies 1–6

Description of gamble	Gamble preference	Subjective likelihood	Simplicity
Study 1 (n = 70, p of event = 31%, sure amount = \$9, payout amount = \$50)			
4 on either roll	5.4_{a}		
4 on the first roll or a 4 on the second roll	4.0_{b}		
2 on the first roll or a 4 on the second roll	3.0_{c}		
Study 2 (n = 151, p of event = 50%, sure amount = \$15, payout amount = \$50)			
Even number	5.4_{a}	4.2_{x}	
2, 4, or 6	5.0_{b}	4.0_{y}	
1, 4, or 6	4.8_{b}	3.8_{z}	
Study 3 (n = 462, p of event = ?, sure amount = \$15, payout amount = \$35)			
Dallas makes field goal during the game	6.3_{a}	$66\%_{x}$	
Opposing team makes field goal during the game	5.7_{b}	$64\%_{y}$	
Dallas makes field goal in 1st half or opposing team makes field goal in 2nd half	4.3_{c}	$53\%_{z}$	
Opposing team makes field goal in 1st half or Dallas makes field goal in 2nd half	4.3_{c}	$53\%_{z}$	
Study 4 (n = 460, p of event = 31%, sure amount = \$9, payout amount = \$50)			
4 on either roll (gain)	4.9_{a}		
2 on the first roll or a 4 on the second roll (gain)	3.8_{b}		
4 on either roll (loss)	4.9_{a}		
2 on the first roll or a 4 on the second roll (loss)	5.4_{c}		
Study 5 (n = 89, p of event = 50%, sure amount = \$15, payout amount = \$50)			
Even number	61.1_{a}	5.6_{x}	8.9_{q}
2, 4, or 6	52.6_{b}	5.2_{y}	8.3_{r}
Study 6 (n = 142, p of event = 88%, sure amount = \$13, payout amount = \$25)			
You roll a six-sided die 3 times and win if you get an even number on any roll	$7.3_{a,b}$	$5.4_{x,y}$	$5.8_{q,r}$
You flip a coin 3 times and win if you get heads on any flip	7.6_{a}	5.5_{x}	6.1_{q}
You draw a card 3 times and win if you get a red card on any draw	7.0_{b}	5.2_{y}	5.7_{r}
You roll a six-sided die, flip a coin, and draw a card and win \$25 if you get heads on the flip, an even number on the roll, or a red card on the draw	6.2_{c}	4.8_{z}	4.6_{s}

Note. Means for a given study sharing the same subscript do not differ at the $p < .05$ level.

11-point scale used in Study 1. After the respondents' gave the final rating, all the filler and focal gambles were presented in random order, and respondents rated the likelihood of winning on a 7-point scale ranging from 1 (*definitely lose*) to 7 (*definitely win*). Finally, to test whether respondents could correctly calculate the probability, we asked them to estimate the chance of winning for each gamble.

We expected that most participants would respond with 50% for the focal gambles and that the complexity effect would remain for those who did because preferences would reflect respondents' intuitive sense of likelihood, not just their consciously computed probability. As Windschitl (2000) noted, soliciting numeric probability estimates often prompts considerations (such as the applicability of formal rules and concerns with conformity to normative standards) that are not evoked by other noncontrastive judgments reflecting degrees of belief (see also Wallsten, Budescu, & Zwick, 1993; Windschitl & Wells, 1996).

Results and Discussion

The packed "even number" gamble was more attractive (M = 5.4 vs. pooled M = 4.9), $t(150) = 2.84$, $p < .01$, $\eta^2 = .05$ and rated as more likely on a subjective verbal likelihood scale (M = 4.2 vs. pooled M = 3.9), $t(150) = 4.02$, $p < .01$, $\eta^2 = .10$. Individual level analyses confirmed the pattern: the even number gamble received higher likelihood ratings than the average unpacked gamble much more often than the reverse (M = 25% vs. M = 6%, $\chi^2(1) = 15.51$, $p < .0001$), and the same result held for judged attractiveness of the gambles when they were rated relative to a sure thing (M = 39% vs. M = 21%), $\chi^2(1) = 8.01$, $p < .0001$. Despite the filler gambles, many respondents presumably recognized the formal equivalence of the packed and unpacked gambles and coordinated their responses appropriately: 69% rated all three gambles as equally likely and 40% rated all three as equally attractive. In that respect, our use of a within-subjects design was likely a conservative test of the phenomenon we postulated.

We also conducted a mediation analysis to test whether the likelihood ratings accounted for the differences in preference. The likelihood ratings were significant in a repeated-measures analysis of covariance (ANCOVA) on the preference ratings, $\beta = 0.92$, $t(148) = 9.14$, $p < .0001$. When we simultaneously modeled the preference ratings using both the packing of the event and the likelihood ratings mediator, the mediator remained statistically significant, $\beta = 0.89$, $t(147) = 8.67$, $p < .0001$, while the packing coefficient went from 0.50 to a nonsignificant 0.28, $t(147) = 1.66$, $p > .09$. A Sobel test confirmed that this mediation was significant, $z = 3.65$, $p < .001$, indicating that the packed gambles were preferred more because they seemed more likely.

As expected, most participants (72% to be exact) correctly answered that the mathematical probability of winning each gamble was 50%. If we restricted our analysis to this group, the effect was preserved: the packed gamble was rated as more attractive than the unpacked gambles (M = 5.3 vs. pooled M = 4.9), $t(107) = 2.40$, $p < .02$, and rated as more likely (M = 4.1 vs. pooled M = 3.9), $t(107) = 2.79$, $p < .01$. In fact, the means and magnitudes of the effects were nearly identical to those for the full sample.

Study 3

The results of the first two studies suggest that the complexity of an event reduces the subjective perception of its likelihood and correspondingly lowers preference for a gamble whose payoff is contingent on its occurrence. This holds even when respondents can correctly calculate the objective probability. In Study 3, this result was further generalized with a focal event whose probability could not be computed: the conversion of a field goal in a future football game. In this case, we expected the effect to extend to "mathematical" probability judgments as well since there was no canonically correct number against which a judgment could be compared, and any violations of logic would be less apparent.

Method

Four hundred and sixty-two participants from an online panel completed this study for a chance to win prizes. In this study, we followed the same design as in previous studies but used events without a defined probability. Specifically, the focal event involved the successful conversion of a field goal in the next Dallas Cowboys football game. Each participant read descriptions of the following four events: (a) "Dallas makes a field goal in the game"; (b) "Opposing team makes a field goal in the game"; (c) "Dallas makes a field goal in the first half or opposing team makes a field goal in the second half"; or (d) "Opposing team makes a field goal in the first half or Dallas makes a field goal in the second half." A pretest indicated that these descriptions would successfully manipulate simplicity as the multiteam gambles took about 50% longer to comprehend ($M = 7.8$ s vs. 5.6 s), $t(226) = 4.18$, $p < .0001$.

The four versions of the gamble were presented in a randomized order amid several unrelated gambles. Using the same 11-point scale as in the previous studies, participants indicated their preference for either receiving a sure \$15 or receiving \$35 if the described event obtained. We predicted that the two simpler gambles involving a single team would be preferred to the two complex gambles involving the concatenation of subsidiary events. After making their last choice, participants were again shown all of the filler and focal gambles and asked to estimate the probability of winning.

Results and Discussion

A repeated-measures analysis of variance (ANOVA) with pooled contrasts for the number of teams mentioned in the winning event (one or two) confirmed our predictions. As revealed in Table 1, two-team gambles were judged as less likely (pooled $M = 53\%$ vs. $M = 66\%$), $t(458) = 10.41$, $p < .0001$, $\eta^2 = .32$, and less attractive (pooled $M = 4.3$ vs. $M = 5.9$), $t(458) = 13.79$, $p < .0001$, $\eta^2 = .17$. At the individual level, 55% of participants had a stronger preference for the one-team gambles over the two-team gambles, versus just 15% showing the opposite pattern, $\chi^2(1) = 103.68$, $p < .0001$. Similarly, 64% judged the one-team gambles to be more likely, compared with just 12% who judged them as less likely, $\chi^2(1) = 160.03$, $p < .0001$.

These results support our predictions. They also imply a mutually inconsistent set of beliefs. For example, if the Dallas gamble is judged as more likely than both of the mixed gambles, it implies that Dallas is more likely than the opposing team to kick a field goal in the first half and in the second half. But this, in turn, implies that both of the mixed gambles ought to be preferred to the "opponent" gamble, contrary to the observed pattern of preferences.

We also tested whether changes in the probability estimates mediated the preference effects. The likelihood probability estimates were significant in a repeated-measures ANCOVA on preferences for the gambles, $\beta = 0.06$, $t(455) = 17.45$, $p < .0001$. When the model of the preference ratings also included a dummy for the complexity of the event, the probability estimates remained a statistically significant mediator, $\beta = 0.05$, $t(454) = 15.70$, $p < .0001$, while the complexity coefficient decreased from 1.63, $t(455) = 9.17$, $p < .0001$ to 1.00, $t(454) = 5.79$, $p < .0001$. Although the probability estimates did not fully mediate the effect of complexity on preference, a Sobel test confirmed significant mediation, $z = 8.68$, $p < .0001$.

Study 4

Thus far, our results are largely consistent with those of Heath and Tversky (1991) that suggest respondents are more reluctant to bet on events they feel less qualified to assess. The results are also consistent with a finding that more fluent events are more favorably evaluated (Schwarz, 2004). These theories both imply that complex events will be disliked relative to simpler counterparts, whether the gamble is associated with a reward or a penalty. However, since we view the aversion to complex events in terms of a reduction in subjective likelihood, we predicted that unpacking should increase the attractiveness of complex gambles in the domain of losses. We tested that prediction in this study.

Method

Four hundred and sixty participants from an online panel participated for a chance to win a \$50 gift certificate. Using our stimuli from Study 1, we described the focal event either as getting "a 4 on either roll" or getting "a 2 on the first roll or a 4 on the second roll." Participants encountered each description in both a gain frame (the event paid \$50) and a loss frame (the event carried a \$50 penalty). The order of the four gambles was randomized and mixed among other unrelated gain and loss gambles. As before, we assessed the attractiveness of the gamble in terms of strength of preference versus a sure \$9 gain (or sure \$9 loss) using the same scale as in previous studies. In accordance with the process described earlier, we predicted that the simpler packed gamble would be more preferred in the domain of gains but less preferred in the domain of losses.

Results and Discussion

Supporting our proposal that simplicity is used as a cue for likelihood, we found that the packed gamble was more preferred in the domain of gains ($M = 4.9$ vs. $M = 3.8$), $t(459) = 6.39$, $p < .0001$, $\eta^2 = .08$, but less preferred in the domain of losses ($M = 4.9$ vs. $M = 5.4$), $t(459) = 2.87$, $p < .01$, $\eta^2 = .02$. Individual-level analyses revealed the same pattern: in gains, the packed gamble was more often preferred to the unpacked gamble than the other way around ($M = 42\%$ vs. $M = 23\%$), $\chi^2(1) = 25.81$, $p < .001$), and in losses, the unpacked gamble was more often preferred to the packed gamble than vice versa ($M = 28\%$ vs. $M = 38\%$), $\chi(1) = 6.87$, $p < .01$.

These findings weigh against two alternative interpretations: (a) that more fluent options are generally more attractive (Schwarz, 2004) and (b) that respondents avoid complex events because they feel less competent in assessing them (Heath & Tversky, 1991). That said, the reduction of our "reverse-unpacking effect" in the domain of losses suggests that these processes may have affected the preferences for at least some respondents.

Study 5

Since many theories of probability judgment assume that a focal event is judged, in part, by comparison to alternative events (Dougherty, Gettys, & Ogden, 1999; Dougherty & Sprenger, 2006; Windschitl & Wells, 1998; Windschitl & Young, 2001), one potential alternative account for some of our results is that unpacking the focal event somehow enhanced the salience of the alternatives. For example, if the term "even number" evokes "odd number" less strongly than "2, 4, or 6" evokes "1, 3, or 5," the effects we document could be explained in terms of enhanced availability of alternative outcomes. Though we believe this alternative account cannot readily explain differences between some of our manipulations that do not involve classical unpacking (e.g., why 1, 4, or 6 is less preferred than a 2, 4, or 6), in this study, we attempted to rule out this alternative account by explicitly stating the alternative outcome across both the packed and unpacked versions of the focal outcome. In this study, we also provided more direct evidence of our proposed process by gathering direct measures of the perceived simplicity of the gambles.

Method

Eighty-nine participants completed this study for $6 as part of a 30-min research session involving several unrelated studies. Using the stimuli from Study 2, we chose as the focal event a gamble paying $50 conditional on the outcome of a die roll. The gamble was described either as "win $50 if you get an even number (win nothing if you roll a 1, 3, or 5)" or "win $50 if you get a 2, 4, or 6 (win nothing if you roll a 1, 3, or 5)." Here, it should be noted that we have fixed the alternatives across the conditions and explicitly stated what was merely implied in Study 2—the alternative outcomes that would pay nothing. As before, the two gambles involving these events were presented in random order amid other unrelated gambles (all with explicitly stated alternatives). The attractiveness of the gamble was assessed in terms of strength of preference versus a sure $15 gain, reported on a visual analog scale divided into 101 segments, with the endpoints labeled 0 (*strongly prefer sure thing*) and 100 (*strongly prefer gamble*). After indicating their strength of preference for the gamble, respondents rated the likelihood of winning each gamble on a 9-point scale anchored at 1 (*definitely lose*) and 9 (*definitely win*). Finally, respondents rated the simplicity of the described gambles on an 11-point scale (1 = *very complex* and 11 = *very simple*). As before, we predicted that the packed gamble would be more preferred and judged as more likely and that this would be explained in part by the effects of the unpacking manipulations on judged simplicity.

Results and Discussion

Though the alternative losing outcomes were explicitly stated in both packing conditions, we replicated the results from Study 2: the gamble was more preferred when the winning events were packed rather than unpacked ($M = 61.1$ vs. $M = 52.6$), $t(88) = 2.41$, $p < .02$, $\eta^2 = .06$. The packed description was also perceived to be more likely to pay out ($M = 5.6$ vs. $M = 5.2$), $t(88) = 2.38$, $p < .02$, $\eta^2 = .06$, and was more easily understood ($M = 8.9$ vs. $M = 8.3$), $t(88) = 2.77$, $p < .01$, $\eta^2 = .08$.

The effect on preference was apparently concentrated in a subset of participants, as the packed and unpacked gambles were chosen with equal frequency over the sure thing when analyzed at the individual level ($M = 49\%$ vs. $M = 48\%$), $\chi(1) < 1$, *ns*). A post-hoc explanation is that the 101-point scale used in this study was more sensitive to weak differences in preference than the eleven-point scale in Study 2 (which did find an effect at the individual level). The other measures support this notion. When analyzed at the individual level, more participants rated the packed gamble as more likely than the unpacked gamble ($M = 28\%$ vs. $M = 15\%$), $\chi^2(1) = 3.79$, $p < .06$, and as simpler ($M = 34\%$ vs. $M = 19\%$), $\chi^2(1) = 3.60$, $p < .06$.

We have posited that judgments of simplicity or fluency drive these effects. To test this notion, we performed a mediation analysis using a series of repeated-measures ANCOVAs. The attractiveness of the gamble was correlated with the judged simplicity, $\beta = 5.96$, $t(87) = 5.60$, $p < .0001$. If attractiveness was simultaneously regressed on both simplicity and description (packed vs. unpacked), the simplicity mediator continued to be significant, $\beta = 5.64$, $t(86) = 5.23$, $p < .0001$, whereas the coefficient for packing declined from 8.49, $t(87) = 2.41$, $p < .02$, to a nonsignificant 5.20, $t(86) = 1.54$, $p > .12$. A Sobel test confirmed that the attractiveness of the gambles was explained in part by the negative effects of unpacking on judged simplicity, $z = 2.45$, $p < .02$.

We have further proposed that simplicity affects preference through its effect on perceived likelihood. To fully demonstrate the proposed two-stage process sketched in Figure 1, we next tested whether judged likelihood mediated the effect of simplicity on preference. Likelihood was a significant predictor of preference, $\beta = 7.43$, $t(87) = 4.96$, $p < .0001$. When an analysis of preference included both simplicity and likelihood, the likelihood mediator remained as a significant predictor, $\beta = 5.28$, $t(86) = 3.50$, $p < .001$, and the coefficient for simplicity fell from 5.96, $t(87) = 5.60$, $p < .0001$, to 4.77, $t(86) = 4.38$, $p < .01$. Thus, as these results suggested and a Sobel test confirmed, perceived likelihood partially mediated the effect of simplicity on gamble preference, $z = 2.95$, $p < .01$.

Further, we also found that simplicity mediated the effect of unpacking on likelihood ratings. Simplicity was a significant predictor of likelihood, $\beta = 0.27$, $t(87) = 5.48$, $p < .0001$. When the analysis of likelihood included both simplicity and unpacking, the simplicity mediator remained a significant predictor, $\beta = 0.26$, $t(86) = 5.05$, $p < .0001$, and the unpacking coefficient dropped from 0.39, $t(87) = 2.38$, $p < .02$, to a nonsignificant 0.24, $t(86) =$

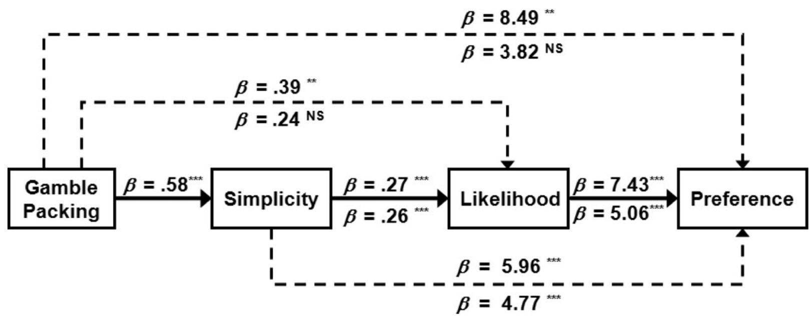

Figure 1. Mediation analyses in Study 5. Simple tests are shown above each line. Tests in the regression model with the mediator are shown below each line. NS = nonsignificant. $^{**}p < .01$. $^{***}p < .001$.

1.60, $p > .11$. A Sobel test confirmed that simplicity significantly mediated the relationship between packing and subjective likelihood, $z = 2.43$, $p < .02$. To complete our summary of the relations displayed in Figure 1, note that if packing, simplicity, and likelihood were all considered together as predictors of gamble preference, likelihood remained a highly significant predictor of preference, $\beta = 5.06$, $t(85) = 3.33$, $p < .01$, and its inclusion in the model reduced the coefficients of packing to 3.82, $t(85) = 1.16$, $p > .25$, and of simplicity to 4.58, $t(85) = 4.16$, $p < .01$.

Study 6

When the mathematical probability of some event (e.g., rolling an even number on a die) is easily computed, respondents can coordinate their preference ratings to conform to their computations, which likely diminishes the role of more intuitive impressions such as simplicity. Thus, we expected simplicity to more fully mediate preferences when objective likelihood cannot be so readily computed. In this study, we used more complex events whose probability would be difficult for respondents to compute, which we had learned from prior studies in which participants judged the probability of getting at least one head in three coin flips. Though the participants in these studies were drawn principally from student populations at elite universities (see Frederick, 2005), fewer than one in seven generated an answer that was within 10% of the correct answer.

Method

One hundred and forty-two undergraduates completed this study in exchange for course credit. Respondents considered one of four different gambles: three homogeneous elementary gambles and one complex composite gamble that included an event from each elementary gamble.

Elementary gambles. (a) "You roll a six-sided die three times and win $25 if you get an even number on any roll"; (b) "You flip a coin three times and win $25 if you get a heads on any flip"; or (c) "You draw a card three times and win $25 if you get a red card on any draw."

Composite gamble. (d) "You roll a six-sided die, flip a coin, and draw a card and win $25 if you get heads on the flip, an even number on the roll, or a red card on the draw."

As in prior studies, the attractiveness of the presented gamble was judged relative to a certain reward ("win $13 for sure"). Although the four gambles are statistically equivalent,[3] we expected that the unpacked composite version would be the least preferred because its elevated complexity would diminish its apparent likelihood. To test this, after respondents had given their final preference rating, we presented each gamble again, and respondents rated its subjective likelihood (1 = *definitely lose* and 7 = *definitely win*) and simplicity (1 = *very complex* and 7 = *very simple*) in that order.

Results and Discussion

Relative to the composite gamble, the elementary gambles were judged to be simpler (pooled $M = 5.9$ vs. $M = 4.6$), $t(141) = 8.04$, $p < .0001$, $\eta^2 = .31$, more likely (pooled $M = 5.4$ vs. $M = 4.8$), $t(141) = 4.48$, $p < .0001$, $\eta^2 = .12$, and more attractive (pooled $M = 7.3$ vs. $M = 6.2$), $t(141) = 4.17$, $p < .0001$, $\eta^2 = .11$. Furthermore, when analyzed at the individual level, it was more common to give a higher rating to the elementary gambles than to the composite gamble ($M = 45\%$ vs. $M = 30\%$), $\chi^2(1) = 4.12$, $p < .05$. Those individual level analyses yield similar patterns when analyzing ratings of likelihood ($M = 54\%$ vs. $M = 34\%$), $\chi^2(1) = 6.32$, $p < .02$, and simplicity ($M = 68\%$ vs. $M = 22\%$), $\chi^2(1) = 33.27$, $p < .0001$.

As shown in Figure 2, packing level (coded as elementary or composite) predicted simplicity judgments, $\beta = 1.22$, $t(138) = 8.88$, $p < .0001$, which predicted likelihood ratings, $\beta = 0.33$, $t(138) = 10.54$, $p < .0001$, which predicted preference for the gamble over the sure thing, $\beta = 0.85$, $t(138) = 7.90$, $p < .0001$. To fully test for the mediation process we proposed, we performed a series of four mediations using repeated-measures ANCOVAs.

First, the simplicity mediator was related to the dependent variable of preference, $\beta = 0.43$, $t(138) = 4.73$, $p < .0001$. When the preference ratings were analyzed with a model that included both the packing variable and the simplicity mediator, the mediator remained significant, $\beta = 0.35$, $t(137) = 3.60$, $p < .001$, while the

[3] The gambles are strictly equivalent only if the cards are reshuffled each time. If sampled without replacement, the probability of winning the cards gamble is 88.2%, not 87.5% because misses remove black cards from the remaining deck. We recognized but chose to ignore this technicality. Though the cards gamble was slightly superior to the others under a "without replacement" interpretation of the task, it was actually the least attractive of any of the elementary gambles.

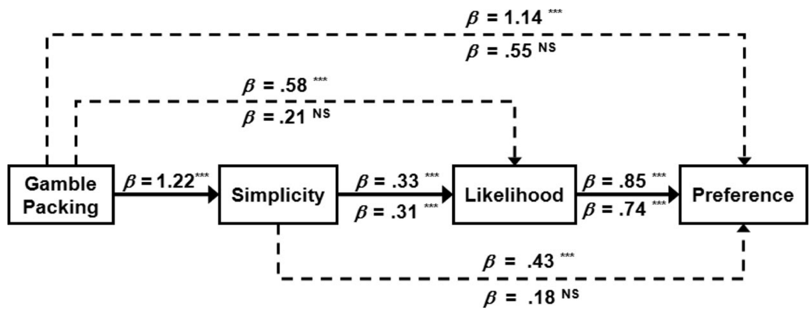

Figure 2. Mediation analyses in Study 6. Simple tests are shown above each line. Tests in the regression model with the mediator are shown below each line. NS = nonsignificant. *** $p < .001$.

packing coefficient decreased from 1.14, $t(138) = 3.57$, $p < .001$, to a nonsignificant 0.63, $t(137) = 1.86$, $p > .06$. This mediation of preference through simplicity was significant, Sobel $z = 3.34$, $p < .001$.

Second, when the analysis of likelihood also included the simplicity mediator, simplicity remained significant, $\beta = 0.31$, $t(137) = 9.09$, $p < .0001$, but the coefficient for packing went from 0.58, $t(138) = 4.97$, $p < .0001$, to a nonsignificant 0.21, $t(137) = 1.79$, $p > .07$. Perceptions of simplicity mediated the effect of packing on likelihood ratings, Sobel $z = 6.35$, $p < .0001$.

Third, simplicity mediated preference largely through its influence on likelihood. When we analyzed preference using both simplicity and likelihood ratings, likelihood remained largely unchanged, $\beta = 0.76$, $t(137) = 6.48$, $p < .0001$, while simplicity no longer remained significant, $\beta = 0.18$, $t(137) = 1.85$, $p > .06$. This mediation was significant, Sobel $z = 5.52$, $p < .0001$.

Finally, when we analyzed preference after adjusting for all of the factors in Figure 2, the only significant effect was likelihood, $\beta = 0.74$, $t(136) = 6.28$, $p < .0001$. There was no longer an influence of simplicity, $\beta = 0.12$, $t(136) = 1.22$, $p > .22$, or packing, $\beta = 0.55$, $t(136) = 1.66$, $p > .09$. The pattern of results across these analyses indicated that for the documented unpacking effects, perceived simplicity was the distal mediator, and judged likelihood was the proximal mediator.

General Discussion

In six studies, we found that unpacked events are rated as less likely and make for less attractive bets when gambles contingent on the event in question are compared with certain smaller rewards. These effects occur even when unpacking has no effect on "mathematical" probability estimates. Notably, our results contrast with a large body of research showing that unpacking an event into its elemental constituents increases judged likelihood (Fox & Tversky, 1998; Rottenstreich & Tversky, 1997; Tversky & Koehler, 1994) or has no effect for typical exemplars (Sloman et al., 2004). They also contrast with a smaller body of research showing that people use the number of ways to win as a cue for likelihood (Kirkpatrick & Epstein, 1992; Starmer & Sugden, 1993) and with recent work finding that people prefer diversity when playing repeated gambles (Ayal & Zakay, 2009).

Our results are largely consonant with past work on ambiguity aversion (Ellsberg, 1961), ignorance aversion (Heath & Tversky, 1991), and complexity aversion (Sonsino, Benzian, & Mador, 2002). Indeed, we suspect all of these results may be at least partly understood as an effect of complexity on subjective likelihood. This interpretation is consistent with research showing that ease in processing affects a wide range of judgments including truth and frequency (Alter & Oppenheimer, 2009; Schwarz, 2004).

We propose that the discrepancies between our studies and other unpacking studies can be partially resolved by recognizing two opposing effects of unpacking: (a) psychological expansion of the target category through enhanced accessibility of some of its elements (e.g., a reminder that unnatural deaths include suicides) and (b) reduced processing fluency due to the greater detail that accompanies explicit delineation of the elements of a category. In much of the classic work on unpacking, the accessibility effect outweighs the dysfluency effect. However, the events used in our studies have well-defined extensions involving a small number of typical exemplars that can all be quickly summoned. Thus, in these cases, unpacking diminishes fluency more than it increases the psychological extension or "support" for the specified event. As a consequence, we observe the reverse of the effects that are typically documented. (See also Windschitl & Young, 2001, who discuss circumstances in which the effects of accessibility are possibly neutralized.)

The interplay of these opposing forces helps explain why unpacking effects are not consistently found (Fox & Tversky, 1998; Rottenstreich & Tversky, 1997; Sloman et al., 2004). Though we posit that complexity serves as a negative cue for likelihood, it is by no means the only cue. Deliberate or incidental manipulations of complexity can still activate larger opposing forces. Consider an example we owe to a reviewer. In Tversky and Kahneman's (1983) classic example of the representativeness heuristic, the category "feminist bank teller" is surely more complex than the category "bank teller" as the modifier feminist adds an additional concept to comprehend. Yet in the context of that study, the additional detail also markedly increased the resemblance between that category and the vignette describing Linda's personality. The similarity between the two was a strong positive cue for Linda's membership in the described category that overwhelmed the presumably much smaller negative cue associated with the slightly diminished ease of comprehending the meaning of that more detailed category. Thus, we are surely not arguing that complexity alone is the sole, or even predominant, influence in probability judgments across a variety of contexts. We argue only that it is a factor that should be accounted for when the effects of unpacking are considered and one which can help explain discrepancies in the magnitude (or even direction) of unpacking effects across studies.

The effect of complexity we posit is not limited to manipulations involving strict unpacking, and indeed, the gamble variants used in our studies ranged from classic unpacking, in which the elements are explicitly articulated, to other substitutions involving functionally equivalent though nonisomorphic variants (such as comparing a die roll of 2, 4, or 6 with 1, 4, or 6). As noted earlier, two equally (un)packed descriptions may differ in complexity because of differences in the ease with which the entailed extension can be construed in terms of a simpler conceptual category, such as "even number." Furthermore, though unpacking usually diminishes fluency, number of elements is not the only determinant. For example, in the domain of die rolls, the unpacked description of "1, 3, or 5" is presumably simpler than the packed description of "number whose spelling ends in e."

Though we have positioned our work as an exploration of the boundary conditions of unpacking effects, the role of complexity on intuitive likelihood has broader significance for studies involving judgment and choice under uncertainty. For example, we divided 230 respondents into two groups and had both groups choose between a sure $15 and a chance of getting $100. For one group, that chance was specified as 1/4. For the other, it was specified as 73/291. Though offering slightly higher chances of winning, the gamble involving the more complex expression was chosen only half as often, 21% vs. 40%; $\chi^2(1) = 9.94$; $p < .01$. Such effects call attention to the potential importance of representational details when one is comparing studies, since the complexity of the probabilistic expressions can vary markedly for incidental or intentional reasons.

In conclusion, we propose that the subjective experience of complexity is one important determinant of the overall psychological impact of packed and unpacked events. Although our studies were restricted to stylized gambles involving coins and dice, our findings pertain more broadly. We would posit that any manipulation that increases the apparent complexity of an event will typically reduce its believability, all else being equal. For instance, elaborating the benefits of a medical treatment in great detail may actually reduce one's confidence in the procedure. Conversely, more extensive and elaborate disclaimers spelling out the potential side effects (e.g., may cause drowsiness during the weekend or during the week) may paradoxically reduce the negative impact of such disclaimers. In future studies, researchers will clarify the areas in which judgments and choices can be influenced by logically equivalent descriptions that vary in detail or ease of comprehension.

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