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Comparison-specific preferences: The attentional dilution effect for delay and risk

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Abstract

In cross-modal decisions, the options differ on many attributes, and in uni-modal decisions, they differ on few. We supply new theory and data to understand how discounting for both delay and risk differs between cross-modal and uni-modal decisions. We propose the attentional dilution effect in decision making in which (a) allocation of limited attention to an attribute determines that attribute's decision weight and (b) the attention an attribute receives is increasing in the difference between options on that attribute and decreasing in the number of other attributes that differ between options. We introduce the *random order delayed compensation method* and conduct two experiments focusing on delayed and risky receipt of consumer goods. Consistent with the attentional dilution effect, we find that in this domain, patience and risk tolerance are generally higher in cross-modal than uni-modal decisions. We suggest that, since many real-world choices are cross-modal, people may be more patient and risk-tolerant in their everyday life than is suggested by standard lab experiments.

KEYWORDS
attention, comparison-specific preferences, cross-modal, intertemporal choice, risky choice

1 | COMPARISON-SPECIFIC PREFERENCES FOR DELAY AND RISK

All options are bundles of interconnected attributes. Owning a car, for example, entails the possession of wheels, an engine, and the potential for speed, fuel consumption, and the pleasure of driving. Two important attributes of options are *delay* and *risk*. These attributes have been extensively studied and have well-known parallels in their impact on decisions (e.g., Luckman et al., 2020; Prelec & Loewenstein, 1991). We will focus on a key feature of delay and risk that may underlie these parallels but is also more basic: They both affect, or modify, most other attributes. If the delivery of a car is delayed then so is the receipt of its other attributes; and if delivery is not guaranteed then neither is receipt of those other attributes. We call such attributes "modifiers." Delay and risk are among the most important modifiers.

Leading decision theories often hold that the overall attractiveness of an option is captured by some function of the attractiveness of its outcomes (meaning its *non-modifier* attributes) weighted by functions of the modifiers, such as discount functions or probability weighting functions. We previously studied the modifier "delay" and showed that its impact on preference is incompatible with most decision theories of this form (Cubitt et al., 2018). Specifically, we showed

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that people could appear impatient or patient depending on whether the outcomes were very similar to one another, or very different. In this paper, we further develop our theoretical framework and apply it to risk as well as delay. We also provide two empirical tests using an enhanced experimental design. We show how and why, under a broad range of circumstances, people may be more risk-tolerant and patient than suggested by standard laboratory measures. More fundamentally, we explore how the proliferation of attribute-differences may reduce the influence of any given attribute (modifier or otherwise) on a comparison of options. Consequently, there is a significant limitation in a wide class of models of delay and risk preference that we call *value-based*.

In value-based (or holistic) models, the value of each option is determined by the consumer's needs and preferences and the option's own attributes (e.g., Kalenscher & Pennartz, 2011; Russo & Dosher, 1988). Value-based models include expected utility theory, prospect theory, discounted utility, and hyperbolic discounting models. While many deviations from value-based models have been proposed (e.g., Kôszegi & Szeidl, 2013; Loomes & Sugden, 1982; Marzilli Ericson et al., 2015; Mellers & Biagini, 1994; Scholten & Read, 2010), they still dominate the field. We introduce an approach that features an *attentional dilution effect*, which predicts that observed delay and risk preferences depend on what is being traded off, and especially on the number of differences between the options, in ways not readily captured by value-based models. By implication, delay and risk preferences are *comparison-specific*.

We begin by reviewing the theoretical ideas underlying our approach and contrast them with the value-based approach. We then explain the random order delayed compensation method, which extends the original delayed compensation method introduced in Cubitt et al. (2018). We report two experiments using the new method. The first confirms earlier results concerning delay. The second extends our empirical analysis to risk. Our findings support the view that there is a common mechanism—attentional dilution—underlying the impact of both these modifiers.

1.1 | Theory

We treat options as bundles of attributes. We consider options that take the form of an outcome combined with a specification of the likelihood with which it will be received, and/or the delay of its receipt. An example is a lottery ticket offering a 20% chance of a new car in 2 months, which we denote as (car, 2 months, 20%) or, in general, (g,t,p). We refer to an option comprising an outcome occurring now with certainty $(g,0,1)$ as "unmodified."

Many models of decisions involving risk or delay are value-based in that they assume each option has a value independent of the other options to which it is compared. This is evident in the most obvious way to define the impact of delay and risk on the value of an outcome *g* as the value of the unmodified outcome, weighted by functions of the modifiers:

$$v(g,t,p)=\delta(t)\pi(p)v(g,0,1),$$

where $\delta(t)$ and $\pi(p)$ are, respectively, discount and probability weighting functions. This is not the only way to conceptualize delay and risk within the value-based approach. In cumulative prospect theory, for example, the contribution of one outcome to the value of a risky option depends on its rank relative to other outcomes that might occur (Tversky & Kahneman, 1992). Relatedly, in the sequences model of Loewenstein and Prelec (1993), the value of an option composed of a sequence of outcomes is partly dependent on the order in which they occur. The general property of being value-based does not restrict how values are computed but only requires each option to have a subjective value fixed by its own attributes and that preferences over a set of options matches the ranking of these values.

Value-based models do not capture the whole story. Counterexamples are found in menu or choice-set effects such as the compromise and attraction effects (e.g., Noguchi & Stewart, 2014; Simonson, 1989), in which preferences over a pair of options depend on a third option, which is not itself preferred. Perhaps the primary cause of these effects is attribute-wise comparison. For instance, momentarily setting aside the issues of delay and risk, if the options are two cars, they might be compared on efficiency, speed, comfort, and so forth. If the options differ on one or more attributes, then each such attribute-wise comparison constitutes an argument for one option and against another. If individual comparisons are influenced by other comparisons being made at the same time, then choice-set effects can emerge.

We investigate a new effect that we call *attentional dilution*. It emerges when people assess *how much better* one option is than another. The ability to make such assessments does not require the existence of separate option values, but only the capacity to make comparisons. We operationalize this with a concept of *compensation* which is the payment needed to make the decision-maker just willing to accept one option over another. Besides providing a tractable experimental measure of preference strength, this concept resonates with real-world decisions, such as how much more one must be paid to take a more dangerous job. Attentional dilution entails that the more attributes there are on which two options differ, the lower the decision weight put on any such attribute, so the smaller the contribution of that attribute to compensation.

Attentional dilution is entailed by three highly intuitive principles. The first is that an attribute contributes more to compensation the more attention it receives. So in the limit, if an attribute is ignored, it will have no effect on compensation; whereas, if it is the only attribute that receives attention, it alone will determine compensation. This idea is reminiscent of many theories of choice (see Weber & Johnson, 2009). Perhaps the closest to our account is that of Bordalo et al. (2012, 2013). The determinants of attention are given in the second and third principles.

The second principle is that attention is limited. Consequently, the more attributes are considered, the less attention is available (on average) for any considered attribute. The notion that attention is limited is uncontroversial (cf., Craik, 2020; Kahneman, 1973). Our assumption is that, even while there is some capacity to increase the attention allocated to a given task, spreading attention across more attributes will typically decrease the average attention paid to each one.

The third principle determines which attributes are considered and to what extent. Only differentiating attributes are considered; and they receive attention depending on their salience. Salience will increase the more the options differ on an attribute and will also increase with the prior importance of the attribute to the agent. Whereas the first principle links compensation to attention, the second links attention to the number of attributes considered, and the third principle links that attention to specific attributes.

Attentional dilution follows from these principles. As the attributes on which options differ proliferate, the decision maker's limited attention must be spread over more attributes. The addition of each extra differentiating attribute will decrease attention to the "pre-existing" differentiating attributes, and consequently their contribution to compensation will decrease as well.

Return to the example of a decision involving two cars. Imagine one has steel wheels and the other has stronger and lighter alloy wheels. Consider two scenarios. In Scenario 1, wheel type is the only difference between cars; in Scenario 2, it is one of many differences (e.g., the cars are of different makes). The attentional dilution effect is that the contribution of wheel type to compensation will be greater in Scenario 1 than in Scenario 2, because wheels receive more attention in Scenario 1. For instance, suppose you are willing to pay $100 more for a car with alloy wheels in Scenario 1. We predict that in Scenario 2, the contribution of wheel type to your compensation will be less than $100.

This section has so far focused on attributes that are not what we defined as modifiers, largely because the intuition in the case of non-modifiers is more obvious (if rarely discussed or tested). We suggest this argument applies to modifiers as well. The impact of a given modifier on compensation will be smaller when it is one of many differences between options than when it is the only difference. This produces our key claim: People will be more patient and risk-tolerant when the options differ in many ways besides the modifiers.

1.2 | Predecessors

Critiques of expected utility theory have often drawn on thought experiments in which adding features to an option could affect some choices but not other choices that are theoretically equivalent. Lehrer and Wagner (1985) described the example of a boy offered a choice between a pony and a bicycle for a present.[1] The boy is indifferent and so cannot decide. As such, improving one option should break the indifference, so the bicycle dealer offers to put a bell on the bicycle. Yet, while the boy now clearly prefers this belled bicycle to the unbelled one (corresponding to our Scenario 1), he remains indifferent between the pony and the belled bicycle (corresponding to Scenario 2). Tversky (1972) gave a similar example involving two vacations, one to Paris and one to Rome, between which someone is indifferent. Adding a complimentary bottle of water to the Paris vacation will produce an option that is preferred to Paris without the water, yet the person remains indifferent between Paris + water and Rome. In these examples, the impact of the bicycle bell and the water are governed by effects like attentional dilution, but they differ from our setting in that (a) they rely on indifference between the two unmodified options, and (b) they concern choice rather than compensation. Initial explanations for these thought experiments were based on semi-ordered preference (e.g., Luce, 1956), in which preferences between options are determined up to a margin of error. Related research in perception showed that when comparisons were more difficult—as the Paris + water versus Rome choice is more difficult than the Paris + water versus Paris choice—choice probabilities became closer to 50:50 (Tversky & Russo, 1969). We are aware of no similar work assessing compensation.

Mellers and Biagini (1994) proposed that the weight put on an attribute is related to its "spread," so that if the probabilities in two gambles are very different, then probability receives greater weight, while if the payoffs are very different, then payoffs receive greater weight. Moreover, the probability weight is inversely related to payoff differences, and vice versa. Mellers and Biagini examined preference intransitivity, using questions structured like the pony/bicycle and Paris/Rome examples. They did not measure compensation involving gambles having similar payoffs but non-similar probabilities, although a natural multi-attribute extension of their model would predict what we do (viz., that the impact of probability on compensation will increase as payoffs become more similar).[2]

Another related approach is the "cancelation and focus" model of Houston and Sherman (1995), derived from Tversky's (1977) similarity theory, which could explain the pony/bicycle thought experiment (although, to our knowledge, it has not been applied to it). This model draws on two principles: In choice, "common features are canceled and so play a smaller role," and "the remaining unshared features are focused on." When choosing between a belled and an un-belled bicycle the "bicycle" attributes would be canceled, and the presence/absence of the bell focused on. Since one bell is better than none, the belled bicycle is always chosen. As in this example, Houston and Sherman (1995, Houston et al., 2001) considered the implications of their model for choice. Houston and Sherman (1995, p. 358) observe "features shared by both items should cancel out during preference judgments [i.e., choices], leaving the choice to be made on the basis of the unique features of the paired items." Their concept of "focus" is clearly related to our third principle, but Houston and Sherman were not specifically concerned with delay and risk modifiers, as we are, and they were primarily interested in choice, rather than compensation.

[1]A very similar example was provided by Luce and Suppes (1965), who attributed it to personal correspondence with Savage. Lehrer and Wagner attribute their anecdote to Armstrong (1939), but it does not appear there. It is likely that the Luce and Suppes example is the earliest.

[2]A related stream of work in economics adopts similar approaches, with important contributions by Loomes and Sugden (1982), Bell (1982), and Kôszegi and Szeidl (2013).

We emphasize compensation because, besides the importance of strength of preference noted above, it plays an essential role in tests of attentional dilution. Something that masquerades as attentional dilution can occur in choice even when there is none. To illustrate, imagine many choices between pairs of cars, where wheel type is the only difference between cars in each pair. In these choices, wheel type is likely to be decisive every time. But wheel type may be unrelated to choice if the cars in each pair differ in many other ways—even if the contribution of wheel type to compensation would be identical in both conditions. For example, imagine four options. Two are very different cars, denoted A and B, both with steel wheels. The other two are the same cars except improved by the substitution of alloy wheels and are denoted A^+ and B^+. Imagine a heterogeneous population of agents, all making four choices: between A and A^+, B and B^+, A and B^+, and B and A^+. Assume that each option has an unvarying value for each agent, although the agents differ in what these values are. We expect that in the choice between A and A^+ and between B and B^+ everyone would take the "+" option. Yet since the cars are very different it would be entirely consistent for 50% of the same people to choose B over A^+, and 50% to choose A over B^+. Indeed, any distribution of choice proportions for B over A^+ and A over B^+ that sum to no more than 100% is consistent with everybody choosing the car with alloy wheels when both are otherwise identical. Pairwise choices would therefore not tell us whether the alloy wheels were valued less when the cars were different, since choice diversity could be driven by preference heterogeneity combined with other differences (apart from wheel type) between the options. Only by directly measuring the strength of preference between the options through compensation can we identify the attentional dilution effect.

To summarize, early studies of the effect of the number of distinctive attributes primarily focused on pairwise choice and not on compensation, so cannot test the attentional dilution hypothesis. In the next section, we contrast the predictions of attentional dilution on compensation with those of value-based models.

1.3 | Predictions

We focus on the compensation required to make an individual decision maker indifferent between two options. Specifically, we suppose (in line with standard views) that, given two options between which the individual is not indifferent, there is some currency of compensation, and some amount x of this currency, that is just enough to overcome her preference, that is, make her indifferent between the options, provided the one she sees as worse comes with compensation x. The currency of compensation must be numerical and for simplicity, and in our experiments, we will treat it as monetary. While compensation can be defined in other ways, we use compensations of the form just described (known as willingness to accept).

Based on attentional dilution, we predict that the marginal impact on compensation of a given attribute that differs between options is higher the fewer the differentiating attributes. If, for instance, the impact of wheel type on the compensation between two cars is isolated, we propose it would be systematically greater when the cars differ only in wheel type than when they differ in other ways. Alternatively, adapting the pony/bicycle example to a case of non-indifference, adding a bell to a bicycle would produce a greater change in compensation when comparing an un-belled to a belled bicycle than when comparing a pony to a belled bicycle.

We now apply these ideas to the compensation required to offset option timing and risk. Imagine two options that may differ in their delay, in their risk, or in other attributes. Now increase the difference in the other attributes, while holding the modifiers constant. We predict the weight put on delay and risk will decrease. Consequently, the impact of delay and risk on compensation will be lower the more distinctive the options are in other ways.

This prediction contrasts with a fundamental property of value-based models, as we now explain using a simple but, in key respects, very general set-up. Take any four distinct options in any domain and suppose that an individual is not indifferent between any two of them. Under a value-based theory of individual preference, each option must have a subjective value $v(.)$ for the individual, defined on the properties of that option. We label the four options O_1, O_2, O_3, O_4 in order of preference, so that $v(O_1) > v(O_2) > v(O_3) > v(O_4)$. To have a notation for the value difference between any two options, we define ψ_{ij} as the value difference $v(O_i) - v(O_j)$, where $i \neq j$ and $i, j \in \{1,2,3,4\}$. In a value-based theory, these value differences will drive the compensations required to make lower ranked options equal in value to higher ranked ones. But formally, value differences and compensations are distinct objects. We begin with an analysis in the realm of value differences.

Elementary arithmetic implies that the ψ_{ij} terms inherit relationships from their definition above, such as the following simple additivity property: $\psi_{14} = \psi_{12} + \psi_{23} + \psi_{34}$. Below, we use two related properties. One of these, $\psi_{14} - \psi_{23} = \psi_{12} + \psi_{34}$, is just a rearrangement of simple additivity, while the other, $\psi_{14} + \psi_{23} = \psi_{13} + \psi_{24}$, follows immediately from the definitions. For intuition and easy reference, these two equations are illustrated, respectively, by the left-hand side and right-hand side of Figure 1, the *ladder of value*. In Figure 1, the central vertical line is a numerical scale on which each of the four subjective values is located. Each vertical brace is a ψ_{ij} term for some pair of options.

The reasoning in the previous paragraph uses no assumptions about how option attributes determine subjective value. All it requires is a strict preference ordering and for subjective value to be defined on individual options. This is enough for subsets of the value difference terms to acquire the relationships shown in Figure 1.

We now apply these general relationships to a more specific situation, where two options are unmodified (i.e., if chosen, the outcome would be received immediately and with certainty), and the other options are modified versions of the first two (i.e., there is some delay or risk in their receipt). It does not matter whether the modification is a delay or a risk, but we impose that each modified option is modified in the same way (i.e., the same delay or risk). As they are distinct but unmodified, the unmodified options must differ in outcome. We illustrate in Figure 2 with an adaptation of the "Fisher diagram" of Cubitt et al. (2018).

In Figure 2, the two unmodified options are denoted A_u and B_u, respectively, with the capital letters indicating their different outcomes and the subscript their unmodified status. The options can be anything, but in the experiments described shortly, we use a box of chocolates and a fountain pen. The modified counterpart of A_u is A_m and that of B_u is B_m. A choice between an unmodified option and its modified counterpart is uni-modal because only the modification differentiates them. There are two such choices, each between a pair of options connected by a horizontal line (e.g., a choice between a pen now and a pen whose receipt is subject to delay or risk). In contrast, a choice between an unmodified option and the modified option that is not its counterpart is cross-modal, because the two options differ in outcome, as well as in modification (e.g., a choice between a pen now and a box of chocolates whose receipt is subject to delay or risk).

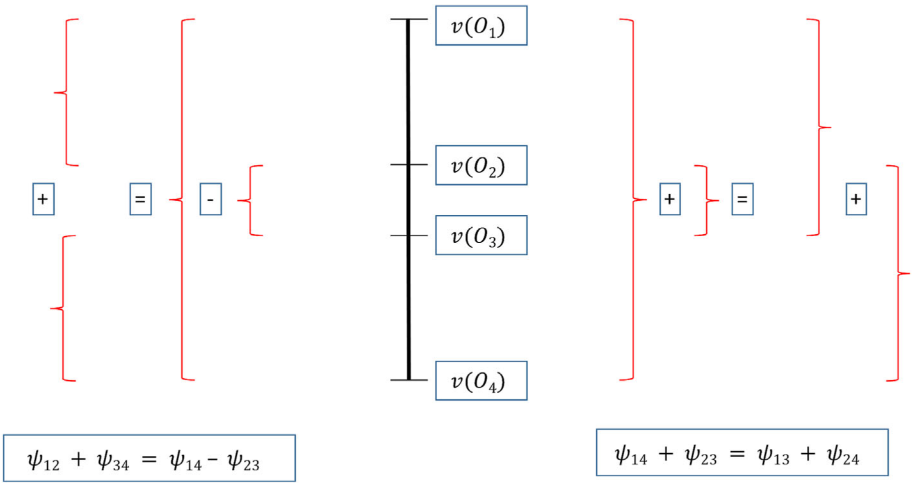

FIGURE 1 The ladder of value. *Note*: the central column is a scale of subjective value of options, with illustrative levels of value for four options marked. The red vertical braces indicate value differences; $+$, $-$, and $=$ indicate relationships between value differences. The equations below the figure summarize the operations depicted by the braces.

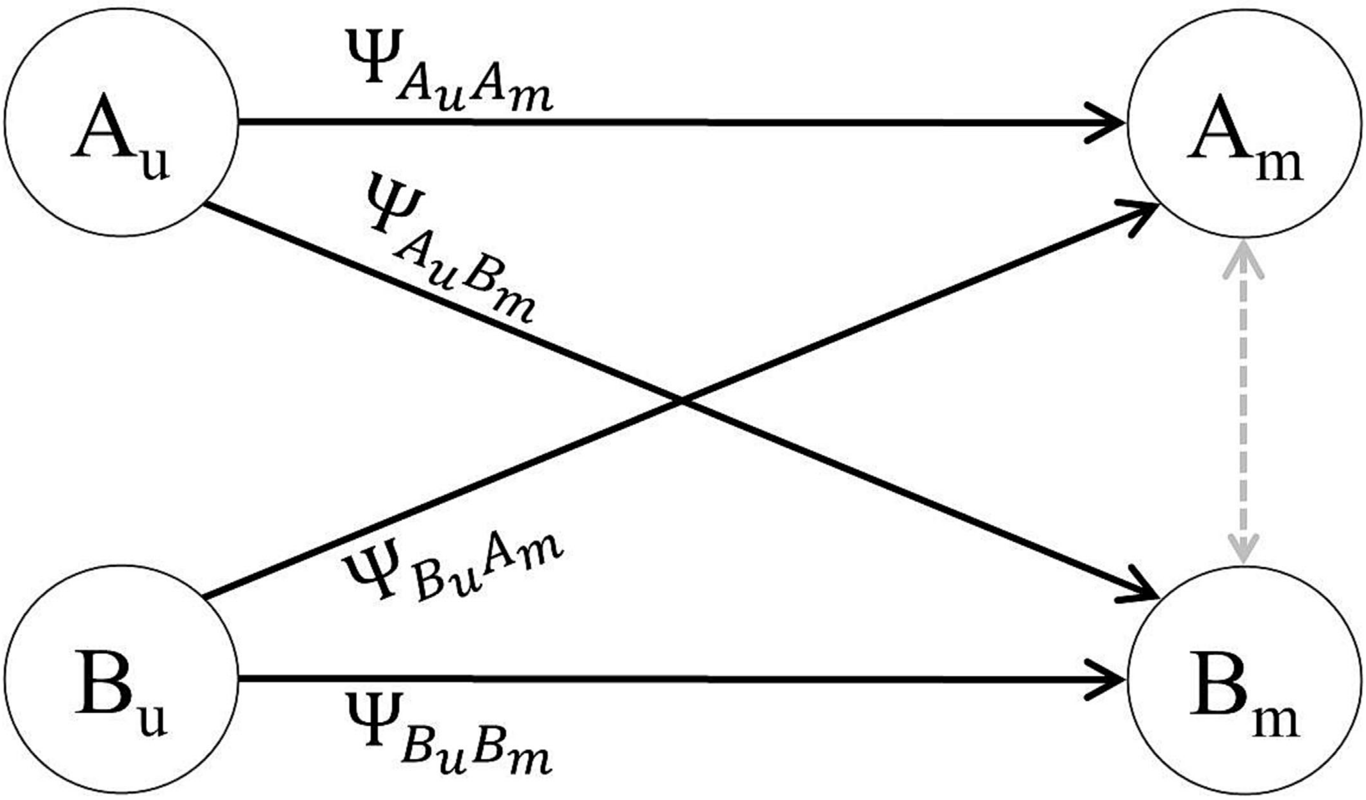

FIGURE 2 The Fisher diagram, so called because of its similarity to a figure in Fisher (1930, chart 4). Note that the terms within circles refer to options distinguished by outcome (A or B) and the presence or absence of modified status (denoted respectively by *m* and *u* subscripts). Arrows are potential exchanges and are accompanied by the relevant value-difference terms. These labels are as for Case 1 in the text. The gray and dashed arrow indicates (implicit) atemporal exchanges.

Again, there are two such choices, this time between options connected by a diagonal line. We will refer to a value difference as uni-modal if it is between the options of a uni-modal choice, and cross-modal if it is between the options of a cross-modal choice. Later we will also apply this usage to compensations, for example, a compensation is uni-modal if it compensates a uni-modal choice.

Suppose there is one outcome (*A*) which is preferred to the other (*B*) when they are both unmodified or when they are both modified; and that modification (be it delay or risk) is aversive. Then, the individual prefers A_u, and disprefers B_m, to every other option. But her preference between B_u and A_m is not determined, as she may be more influenced by the modification than the outcome or vice versa. We consider both cases.

In Case 1, she prefers any unmodified option to any modified one; so that, in terms of the value-based model, $v(A_u) > v(B_u) > v(A_m) > v(B_m)$. Noting how these inequalities determine which options on the Fisher diagram correspond to which values on the ladder of value, and applying the equation on the right-hand side of the ladder of value, we obtain

$$\psi_{A_uB_m} + \psi_{B_uA_m} = \psi_{A_uA_m} + \psi_{B_uB_m} \tag{1}$$

This shows that in Case 1, the *sum* of the cross-modal value differences equals the *sum* of the uni-modal value differences. The Fisher diagram provides an intuition. The (cross-modal) loss of value in exchanging A_u for B_m can be decomposed into one value-loss from exchanging A_u for A_m (from modification) plus a further loss from exchanging A_m for B_m (from switching the outcome). This latter switch is presented in Figure 2 with a dashed gray line. However, the (cross-modal) loss of value from exchanging B_u for A_m decomposes into a value-loss from exchanging B_u for B_m (from modification) offset by a *value-gain* from exchanging B_m for A_m (from switching the outcome). Since the terms due to switching the outcome are of equal magnitude but opposite sign, they cancel when the two cross-modal value-differences are summed, leaving only the sum of the two value-differences. This sum is exactly the sum of the uni-modal value differences.

In Case 2, the individual prefers any option with outcome *A* to any option with outcome *B* so that $v(A_u) > v(A_m) > v(B_u) > v(B_m)$. This time we apply the left-hand side of the ladder of value, and obtain

$$\psi_{A_uB_m} - \psi_{A_mB_u} = \psi_{A_uA_m} + \psi_{B_uB_m} \tag{2}$$

This shows that, in Case 2, the *difference* between the cross-modal value differences equals the *sum* of the uni-modal value differences. Again, the Fisher diagram can provide the intuition if we flip the direction of the arrow linking B_u to A_m, along with the order of options in the corresponding value-difference term (i.e., $\psi_{A_mB_u}$) to accommodate the change in preference ordering. Here, just as in Case 1, the cross-modal loss of value in exchanging A_u for B_m decomposes into a value-loss from exchanging A_u for A_m (from modification) plus a value-loss from exchanging A_m for B_m (from switching the outcome). But, in Case 2, the second cross-modal loss of value is from exchanging A_m for B_u. It decomposes into a value-loss from exchanging A_m for B_m (from switching the outcome) offset by a *value-gain* from exchanging B_m for B_u (removing modification). In Case 2, the outcome-switches are one and the same; and one of the other terms is from adding modification, while the other is from removing modification. Thus, in Case 2, taking the *difference* between the two cross-modal losses of value cancels the outcome-switching terms, leaving only the sum of value-losses from modification. As in Case 1, the result is just the sum of uni-modal value differences.

Equations (1) and (2) give structures to the value differences in Cases 1 and 2, respectively. (The cases are mutually exclusive, so the equations cannot be combined.) These structures generate concrete predictions about monetary compensations when they are driven by value differences. But the exact predictions also depend on the functional relationship between compensation and value difference. We allow two such relationships: Compensation is either linear or strictly convex in value difference. The former is a natural assumption for small-scale options such as those in our experiments, but the latter is an obvious alternative that corresponds to diminishing sensitivity for the currency of compensation. This gives us predictions about the structure of cross-modal and uni-modal compensations, where, for any distinct options *i* preferred to *j*, x_{ij} is the compensation that must accompany *j* to produce indifference. The predictions about compensation from the value-based approach are then

Case 1 (each un-modified option preferred to each modified one):

$$x_{A_uB_m} + x_{B_uA_m} \geq x_{A_uA_m} + x_{B_uB_m}$$

Case 2 (each option with the better outcome preferred to each with the worse outcome):

$$x_{A_uB_m} - x_{A_mB_u} \geq x_{A_uA_m} + x_{B_uB_m}$$

In each case, the condition holds as an equality if x_{ij} is linear in ψ_{ij} and as a strict inequality if that relationship is strictly convex. See Data S1 for details of this convex specification.

The attentional dilution effect predicts strict inequalities in the *opposite* direction to those given above, because it suppresses the impact of modification on cross-modal compensations while increasing its impact on uni-modal compensations. In contrast with the value-based intuitions above, our analysis of attentional dilution does not treat cross-modal compensations as decomposable into outcome-switching terms that are cancellable and modification terms that are the same as one would find in uni-modal comparisons; instead, it treats the impact of modification on compensation as fundamentally different, according to whether the decision is cross-modal or uni-modal.

In this section, we have treated each of the two preference orderings that define Case 1 and Case 2 separately. In the next section, as part of our description of our experimental measures, we explain how, using *signed compensation*, our data analysis caters for subject heterogeneity in which, potentially, some subjects have preferences corresponding to Case 1 and others to Case 2. As a conservative specification, we use the equality formulation of Cases 1 and 2 above when formulating our value-based null hypotheses. These equality formulations and hypotheses are always based on comparisons between two pairs of compensations, the cross-modal pair against the uni-modal pair.

2 | EXPERIMENTS

2.1 | Overview

We report two new experiments that deploy the novel *random order delayed compensation method*, a significantly refined version of the original delayed compensation method (DCM) from Cubitt et al. (2018). The empirical predictions follow straightforwardly from the theory described in the previous section. While they broadly follow Cubitt et al. (2018), there are important differences from that paper in the experimental procedures for elicitation of compensations in both the new experiments and, in Experiment 2, in the modification to be compensated, as we explain.

We test whether attentional dilution effects are found in compensations required in evaluations involving options that differ (wholly or partly) by the presence or absence of modifiers. Experiment 1 tests for the attentional dilution effect in intertemporal choice. This was a replication and robustness check, when compared to Cubitt et al. (2018), testing whether its earlier results survived the more demanding random order DCM (they do). Experiment 2 applies the random order DCM to risky choice, testing whether the attentional dilution effect also holds for risk (it does). By doing so, it extends our evidence that attentional dilution operates from one very important modifier to another.

In both the original and the random order DCMs, respondents narrow down, through a series of connected choices, the compensation required to make them indifferent between an unmodified option (on the left-hand side of Figure 2) and a modified option (on the right-hand side). Compensation is “delayed” because it would be received later than *both* options. (“Delayed” in the term DCM refers to this point and not to any delay that there may or may not be in the modified options themselves.) The delay in the compensation ensures options never become strictly dominated when accompanied by an amount of money sufficient to purchase the unmodified option elsewhere. The advantages of the original DCM (inherited by the random order DCM) and the assumptions underlying it are detailed in Cubitt et al. (2018, especially p. 874 and footnote 10).

There are four key differences between the original and random order DCMs, all pertaining to the “series of connected choices” of the previous paragraph. First, in the original DCM, participants made choices in one of two predetermined orders whereas in the random order DCM, the order of choices was randomized for each participant. Second, in the original DCM, the choices appeared in a list on a single screen in which an increasing sequence of money amounts was added to one option whereas in the random order DCM, choices were presented individually one screen at a time. Third, in the original DCM, participants first made a choice between options unaccompanied by a money amount, and this first choice determined the subset of choices they were then offered whereas in the random order DCM, all participants made all choices, and the first choice had no special status. Fourth, in the original DCM, money amounts were only added to the option not initially chosen whereas in the random order DCM, these money amounts were added to each option (in different choices).

Because of these differences, the random order DCM has several advantages over Cubitt et al.'s (2018) DCM. That paper dealt statistically with the possibility that decisions might be influenced by the systematic way choices were presented. In contrast, in the random order DCM, all such influences are excluded by design. This is significant since, as Cubitt et al. (2018) discuss (pp. 879–881), if the visibility of choice lists to subjects distorts their switching points via a “lure of the middle,” that could contribute spuriously to the appearance of cross-modal effects. Their statistical analysis suggested this was not a major factor, but the exclusion of the effect by design is a crucial robustness check. A further example is that in the earlier design, starting with a choice between uncompensated options might have induced anchoring on the initially chosen option, creating scope for another systematic effect excluded in the present studies. Finally, in the new design, by offering participants all possible choice pairs, we removed the possibility of bias due to each participant seeing only half of the pairs. The random order DCM therefore keeps the conceptual advantages of a choice list from the perspective of the researcher, but with less danger that participants are influenced by inferring the structure of the overall set of choices from what they can see.

3 | EXPERIMENT 1

3.1 | Method

3.1.1 | Participants

We anticipated an effect size of approximately $d = .3$ (Cubitt et al., 2018, obtained $d = .303$). To detect this using 95% confidence levels and with tolerance to type 2 error ($1-\beta$) set at 0.8 required 139 participants per condition (cross-modal and uni-modal) or 278 in total. We aimed for 300 and obtained 306 (Mean age 36; 48% female). These were recruited through Prolific (https://www.prolific.co), restricting participation to US residents aged 18 or over.

3.1.2 | Procedure

The study was conducted online using Qualtrics. The median duration was 8:53 min (min = 3:15, max = 44:09). We obtained ethical approval from the University of Warwick. Participants received the US dollar equivalent of £1 for their participation, equating to a median

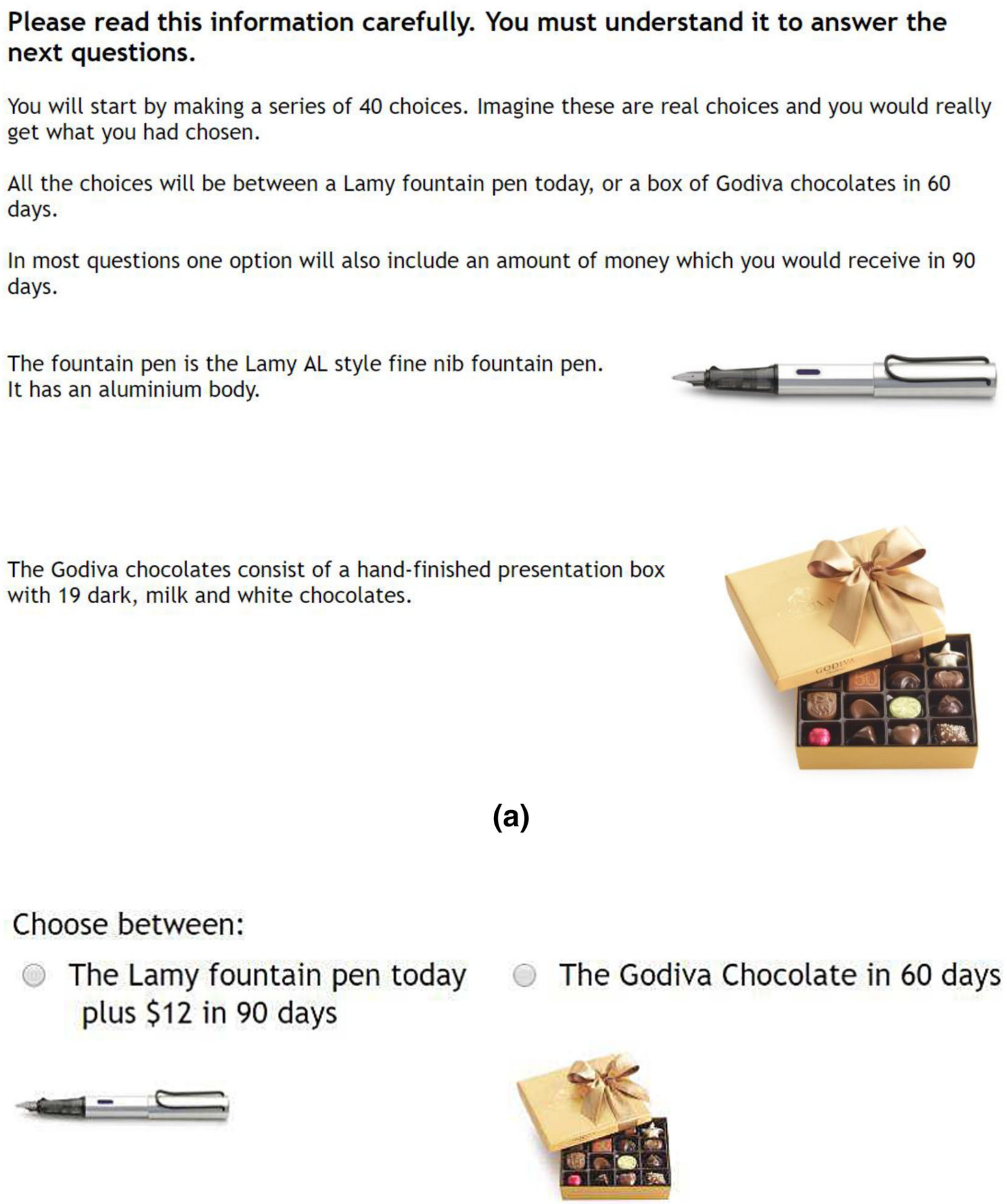

FIGURE 3 (a) Instructions for Experiment 1 in the PeCh condition. Screenshot captured from experiment. (b) Pairwise choice example. Screenshot captured from experiment as seen by participants. Note for Figure 3a,b, an example question in the PeCh condition (with $12 accompanying the earlier good). Screenshot captured from experiment. Questions appeared on separate screens and were presented in random order.

hourly rate of just under £7. The study used hypothetical choices since it was a stipulation of Prolific that we could not obtain participant addresses. As discussed below, our hypothetical results were in line with the incentivized choices of Cubitt et al. (2018).

Participants were randomly assigned into one of four conditions, made up of two uni-modal and two cross-modal conditions. In the uni-modal conditions, they chose between receiving an unmodified option or a modified option including the same outcome to be received in 60 days. In the cross-modal conditions, they chose between receiving an unmodified option or a modified option including a different outcome, again to be received in 60 days. The two outcomes were a box of Godiva chocolates and a Lamy Fountain Pen, as in the earlier paper. Referring to Figure 2, the options on the left-hand side were chocolates or a pen now, those on the right-hand side were chocolates in 60 days or a pen in 60 days. The uni-modal pairs were therefore "Chocolates now OR Chocolates later" and "Pen now OR Pen later." The cross-modal pairs were "Chocolates now OR Pen later" and "Pen now OR Chocolates later." We will refer to the pairs as ChCh, PePe, ChPe, and PeCh, with the first two letters indicating the earlier good and the last two the later good.

Participants first read an introductory screen informing them about the options for their treatment and the general format of the study. Figure 3a shows this screen for the PeCh treatment. Participants then made a series of 40 choices between options designed to pinpoint the compensation (i.e., the delayed money amount) just sufficient to make them indifferent between outcomes in the sense defined above. In each treatment, the outcomes were the same across all 40 choices, but in each choice, one of the outcomes was accompanied by a sum of money (to be received in 90 days) from the set {$50, $45, $40, $35, $30, $25, $20, $18, $16, $14, $12, $10, $8, $6, $5, $4, $3, $2, $1, $0}. Each money amount appeared twice, once with the sooner (unmodified) option and once with the later (modified) option. The money amounts in this list were selected to keep the number of choices manageable while allowing both for more precise estimates when the compensation was small (which we expected), and for theoretically possible large values of compensation. The highest value was a little more than the retail value of the pen and chocolates. Each subject therefore faced 40 choices, presented in random order on separate screens. An example is in Figure 3b.

A further manipulation applies to the description of $0. The absence of a delayed money amount could be described explicitly by writing "plus $0 in 90 days", or implicitly by not mentioning money at all. We had no strong prior basis for choosing between these, but some earlier studies addressing different questions found that including an explicit zero changes measured patience (c.f., Magen et al., 2008; Read et al., 2016). Consequently, we randomized between participants whether the "$0" money amounts were provided explicitly or just not mentioned. Subsequent analysis indicated this made no significant difference (see Table 1).

In addition to the main choices, participants answered a widely used set of 27 smaller-sooner (SS) versus larger-later (LL) monetary intertemporal choice questions from Kirby et al. (1999). Cubitt et al. (2018) reported that a subset of these choices correlated well with uni-modal preferences but not significantly with cross-modal preferences, arguing that this was because standard SS–LL questions effectively pose uni-modal choices. In this experiment, we included the full set of questions. A full analysis of the Kirby SS–LL questions is presented online in Data S4.

Two related self-report questions elicited participants' subjective estimates of the importance of delay to their decisions, as well as how important they considered delay relative to what the options were. An analysis is provided in Data S3, where we report there are few statistically significant differences between the uni-modal and cross-modal cases in the stated importance of delay.

3.2 | Results

Data, analysis code, and study materials are available online (https://osf.io/vqryx/?view_only=04d6a6b9eef04510848e778bf1defdba).

3.2.1 | Signed compensation

As defined previously, compensation is the amount of money which, if it accompanies the dis-preferred of two options, is just sufficient to induce indifference between them. *Signed compensation* is equal in magnitude to that compensation, but signed positive when the compensation accompanies the modified option and signed negative when it accompanies the unmodified option. Signed compensation can therefore be interpreted as the strength of preference for the *unmodified* option.[3] This permits us to aggregate compensation across subjects with different preference orderings. Note that the *difference* in compensation on the left-hand side of Case 2 in our value-based theoretical section above is nevertheless a *sum* of signed compensations.

Our value-based null hypotheses from Cases 1 and 2 can be combined as follows: The mean of the uni-modal signed compensations will equal the mean of the cross-modal signed compensations. In contrast, the attentional dilution hypothesis predicts that the mean of the uni-modal signed compensations will be greater than the mean of the cross-modal signed compensations.

Combining the value-based hypotheses from Cases 1 and 2 in this way involves three logically distinct steps. First, compensations are taken as linear in value differences (recall this is a *conservative* assumption). Second, and trivially, for any individual, equality of the sum of two terms implies equality of the average of the same two terms. Third, we average signed compensations across individuals, who may differ in whether they correspond to Case 1 or Case 2 but who are assigned randomly to conditions.

In Experiment 1, the unmodified option is delivered sooner, and the modified option is delivered later. Because choices were presented separately and in a random order, participants who are uncertain about their preferences might make some choices inconsistent with either pattern. To assign a signed compensation to each participant, we use the following procedure, modified from Kirby et al. (1999)[4]: First, we observe that the 40 choices in our design allow us to identify 38 ranges in which signed compensation could lie. These ranges are −$50 to −$45, −$45 to −$40, …, −$1 to $0, $0 to $1, …, $40 to $45, $45 to $50. For tractability, we interpret indifference within any of these ranges as indifference at the midpoint of the range, giving −$47.50, −$42.50, …, −$0.50, +$0.50, …, +$42.50, + $47.50. Indifference above $50 and below −$50 is not identified. Next, we specify the choice pattern that would be perfectly in line with each of these 38 potential indifference points. For example, the choice pattern perfectly in line with indifference at signed compensation +$0.50 is to choose the later option when it is accompanied by a sum greater than $0.50 and the earlier option otherwise. Then, for each individual and for each indifference point, we count the number of the individual's choices (out of 40) that are consistent (i.e., coincide) with the pattern that would be perfectly in line with the

[3]For the case where the modifier is delay, signed compensation corresponds to "cost of delay" in Cubitt et al. (2018).

[4]We are grateful to a referee for a comment that led to this approach, rather than an earlier one, which did not identify the extent of consistency with the imputed switch-point. The earlier analysis is reported in Data S2.

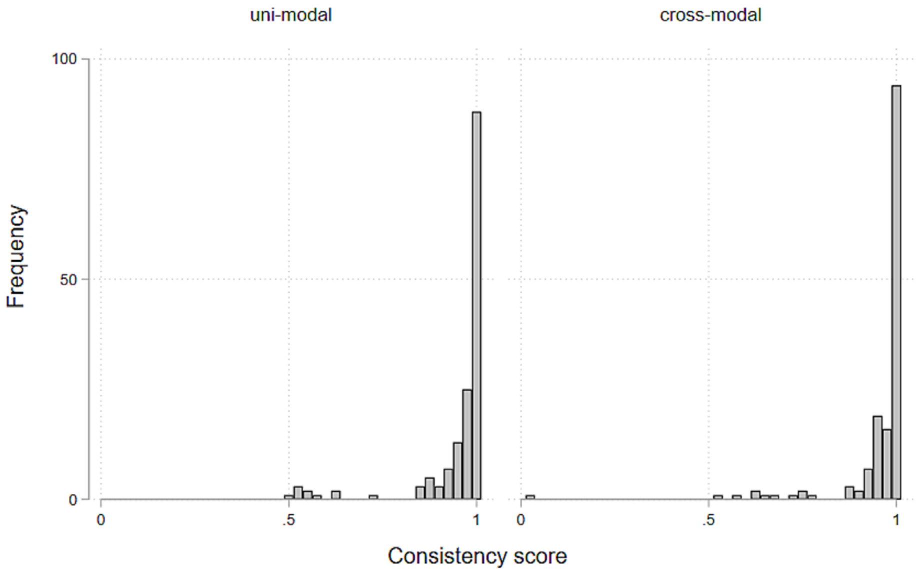

FIGURE 4 Histograms of consistency scores in Experiment 1, with the left panel showing uni-modal and the right panel showing cross-modal observations. These histograms are before excluding the outlier whose consistency score is 0.025.

indifference-point. We thereby identify, for each individual participant, the indifference-point their actual 40 choices are *most* consistent with. Hence (for the case where the result is unique), we discover the individual's most supported indifference point and the associated consistency score, which we express as a proportion of the maximum possible 40. If unique, the most supported indifference point gives the participant's signed compensation; it has a consistency score of 1 if all 40 choices are consistent with it. Where a participant has two or more equally supported indifference points, we take the arithmetic mean of these, and to be conservative, we take their consistency score as the one associated with this mean indifference point.[5] This method records, for individual participant, a signed compensation and its degree of support in their choices; and it uses all 40 of the individual's choices in arriving at each of those measures.

In fact, most participants were entirely consistent (61.8% of participants for cross-modal and 57.1% for uni-modal choices). Figure 4 represents the distribution of the consistency scores for participants assigned to uni-modal and cross-modal conditions, respectively, and shows that this difference in conditions had no effect on consistency. Five participants, three in uni-modal and two in cross-modal, exclusively chose the sooner option or exclusively chose the later option. These participants were imputed a signed compensation of either + $47.50 or −$47.50 if they always chose the sooner option, or always chose the later option, respectively. Their consistency scores were 0.975 (corresponding to 39/40). As an exclusion criterion, we drop participants with a consistency score lower than 0.5. This results in dropping a single individual, in the cross-modal condition, whose consistency score was 0.025 (or 1/40). The median consistency score is then 1, the mean is 0.956, and the standard deviation is 0.0975 (or 3.90/40). Analysis with a more conservative consistency cut-off of 0.9 is presented in Data S5. To summarize, though not every participant was entirely consistent with a unique implied signed compensation, the majority were and, crucially, inconsistency does not affect the comparison of uni-modal and cross-modal compensation, to which we now turn.

[5]For example, imagine a participant whose choice patterns are maximally consistent with switching points of $11 and $15. We define their signed compensation as $13 and their consistency as the proportion of their choices consistent with assuming indifference at $13, which is, of course, lower than the proportion consistent with assuming indifference at $11 or $15.

Comparisons of signed compensation

Figure 5 presents the means and 95% confidence intervals (CIs) for uni-modal and cross-modal signed compensation, as well as the difference between them. The attentional dilution effect prediction, that signed compensation will be greater for uni-modal evaluations, is strongly supported. The means (and 95% CIs) for uni-modal and cross-modal compensation are, respectively, $6.07 (95% CI [$3.96, $8.18]) and $0.57 (95% CI [−$2.15, $3.30])—the corresponding medians are $2.50 and $0.25. The comparison involving means is shown as the third bar in Figure 5. The CI for the difference between uni-modal and cross-modal means, calculated using Satterthwaite-corrected pooled standard errors, comfortably excludes zero. Cohen's *d* for the comparison between the cross-modal and uni-modal groups is .361 calculated using mean squared errors. In sum, using the random order DCM, we find that in the domain of intertemporal choice, uni-modal signed compensation substantially exceeds cross-modal signed compensation.

Table 1 presents OLS regression analyses. The first regression includes only experiment parameters (Model 1) and shows that the average cross-modal signed compensation is $5.48 lower than its uni-modal counterpart and the CIs around this estimate do not include zero. This is further evidence of the attentional dilution effect. Model 1 includes a dummy variable taking the value 1 if the zero was made explicit. Its coefficient is not statistically significant. Model 2 extends this by introducing time preference measured as the time preference rate best supported by the participant's choices in the Kirby et al. (1999) money questions, as well as demographic controls. The time

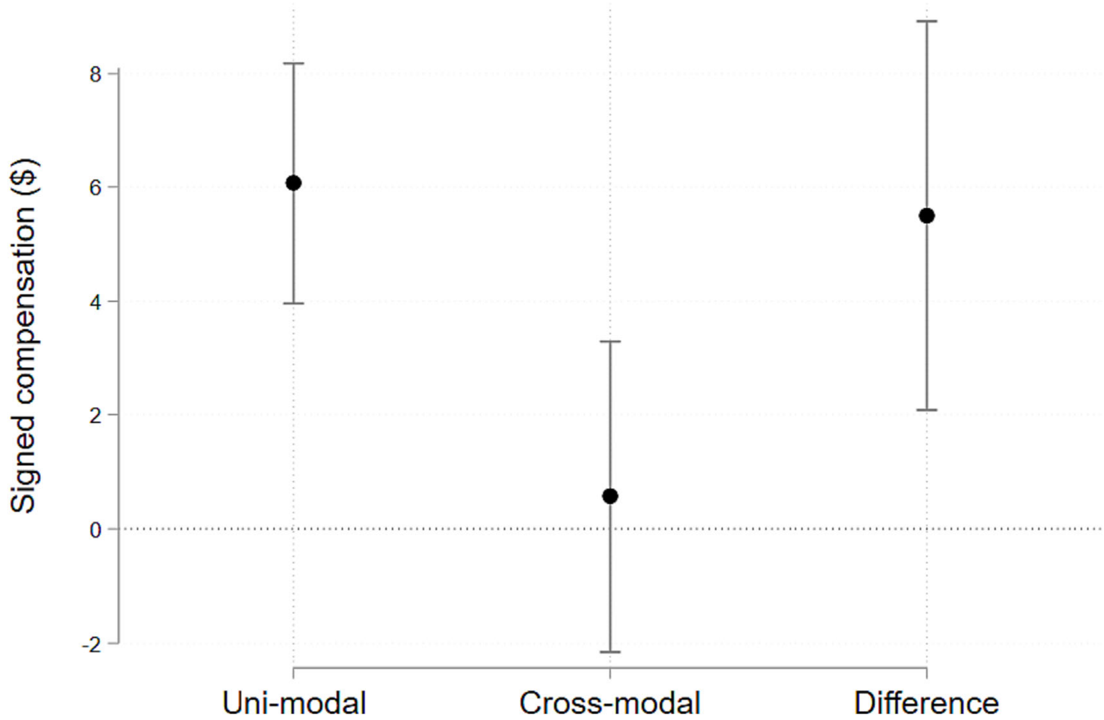

FIGURE 5 The mean signed compensation for uni-modal and cross-modal intertemporal comparisons and their differences with 95% confidence intervals. *Note*: confidence interval for the difference calculated using Satterthwaite-corrected pooled standard errors.

preference measure is predictive of signed compensation in this model. Age and employment are positively related to signed compensation, but no other demographic controls are statistically significant at conventional levels. Models 3a and 3b split the sample by whether the decisions were uni-modal or cross-modal. The time preference measure strongly correlates with signed compensation in the former case but not in the latter. The key take-away from Table 1 is that there are meaningful differences between signed compensation for cross-modal and uni-modal comparisons, and those differences are as predicted by attentional dilution.

3.3 | Comparison with Cubitt et al. (2018)

It is useful to compare Experiment 1 with Cubitt et al. (2018). As noted above, Experiment 1 addresses the same issue as the earlier paper with a related but enhanced design. To allow for comparability, the experimental items were the same in the two studies. As demonstrated in Figure 6, the same pattern of responses was observed in both studies. Besides replicating the earlier findings, this provides evidence that the systematic way the earlier paper presented choices to subjects did not contribute to those findings.

The concepts compared in Figure 6 are the same between the studies, but the analytical approach to finding them is different. Despite this, we get strikingly similar results. Interested readers wanting a direct like-for-like comparison are referred to online Data S2 where we analyses the data from our current Experiment 1 using the methods applied in Cubitt et al. (2018). The results from the two analytical approaches are very similar, and our conclusions remain the same.

4 | EXPERIMENT 2

Experiment 1 confirmed that the weight put on the delay of an option in decisions about compensation is reduced when the earlier and the delayed options are different, rather than the same in terms of the good to be received. In Experiment 2, we extended our design to risky decisions. Although risky and intertemporal choice display many parallels (Loewenstein & Prelec, 1992; Luckman et al., 2020) effects observed in intertemporal choice do not always have parallels in risky choice and in at least one case (the magnitude effect) well-established effects go in the opposite direction. Consequently, we cannot assume an effect observed for the delay modifier must apply to the risk modifier. In Experiment 2, we test the predictions of attentional dilution and value-based models in the domain of risk, where modification is a probability of receipt equal to 50 %.

4.1 | Method

4.1.1 | Participants

Experiment 1 generated an effect size of $d = .361$ (using root mean square standard deviation). To detect an effect of this size, with 95% confidence levels and tolerance to type two error $(1-\beta)$ of 0.8, a

TABLE 1 Regression results from Experiment 1.

Signed compensation ($)	Model 1	Model 2	Model 3a (uni-modal)	Model 3b (cross-modal)
Cross-modal	−5.483**	−5.807***		
	[−8.913, −2.053]	[−9.173, −2.442]		
Explicit zero shown	−0.939	−0.685	−0.868	−0.787
	[−4.369, 2.491	[−4.052, 2.681]	[−4.962, 3.225]	[−6.354, 4.779]
Time preference		42.75*	61.12**	23.79
		[5.765, 79.73]	[18.33, 103.9]	[−40.16, 87.74]
Female		1.820	3.690	0.0401
		[−1.591, 5.231]	[−0.439, 7.819]	[−5.611, 5.692]
Age in years		0.293***	0.296**	0.281*
		[0.131, 0.454]	[0.0861, 0.506]	[0.0291, 0.532]
College education		−0.336	0.371	−1.402
		[−4.056, 3.384]	[−4.173, 4.915]	[−7.587, 4.784]
Married		−0.614	−1.899	0.576
		[−4.063, 2.834]	[−6.121, 2.324]	[−5.006–6.159]
Employed		4.938*	5.895*	4.312
		[0.500, 9.376]	[0.214, 11.58]	[−2.656, 11.28]
Constant	6.535***	−9.421*	−11.52*	−12.74
	[3.587, 9.482]	[−17.60, −1.240]	[−21.08, −1.961]	[−26.47, 0.995]
Observations	305	305	154	151
R^2	.033	.098	.122	.049

***p < .001, **p < .01, and *p < .05.

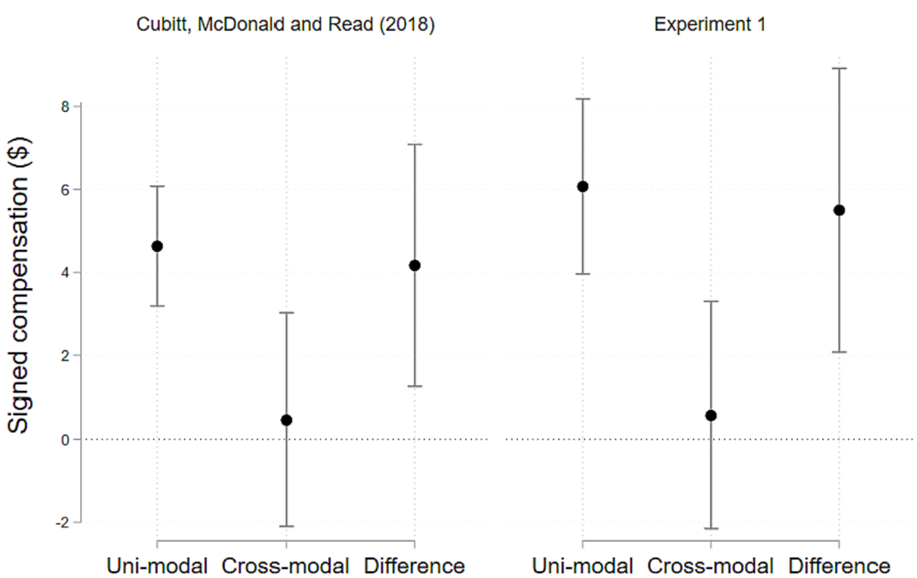

FIGURE 6 The mean signed compensation for uni-modal and cross-modal intertemporal comparisons and their differences with 95% confidence intervals, comparisons between Cubitt et al. (2018) and Experiment 1. *Note*: confidence interval for differences calculated using Satterthwaite-corrected pooled standard errors.

minimum of 121 participants were required for the cross-modal and uni-modal conditions. We obtained 315 participants in total, all non-student US residents aged at least 18. They were recruited through Prolific and paid the US dollar equivalent of £1. Participation was restricted to those who had not taken part in Experiment 1. We did not collect demographic information in Experiment 2 because, at the time, our university ethics committee did not permit it due to (temporarily) heightened concern about protected characteristics. We followed the same exclusion criterion as in Experiment 1.

4.1.2 | Procedure

The experiment was programmed on Qualtrics for online completion. The median duration was 6:23 min (min 2:50, max 17:53). Ethical approval was granted by the University of Warwick.

Experiment 2 closely resembled Experiment 1 in terms of procedure. Participants were randomized into four conditions, but the modifications as represented in Figure 1 involved risk (receipt with 50% chance) as opposed to delay. This changes the interpretation of ChCh,

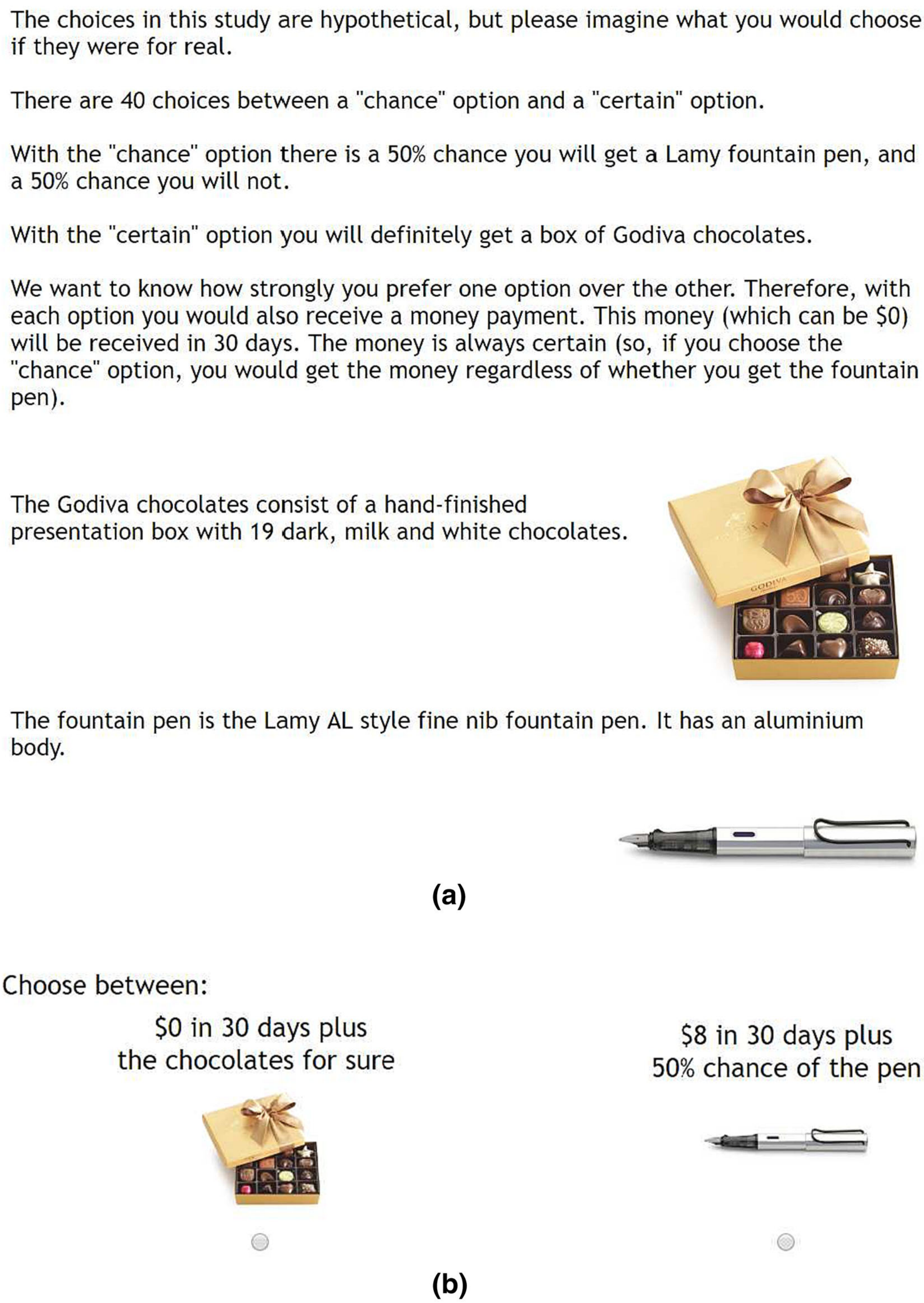

FIGURE 7 (a) Instructions for Experiment 2. Screenshots captured from experiment as seen by participants. (b) Pairwise choice example. Screenshot captured from experiment as seen by participants. *Note*: an example question in the ChPe condition (with $8 accompanying the riskier good). Screenshot captured from experiment. Questions appeared on separate screens and were presented in random order.

PePe, ChPe, and PeCh. For instance, PeCh represents a "Pen for sure OR Chocolates with 50% chance."

The information page for the ChPe treatment is shown in Figure 7a. Participants made 40 pairwise choices of which the one in Figure 7b is an example. Delayed monetary amounts accompanied one option. Recall that the "delayed" term in the concept of the DCM refers to money amounts being delayed longer than any delay on the goods (not to whether or not the goods are delayed). In Experiment

2, the delay on money was 30 days, as shown in Figure 7b so that, just as in Experiment 1, the delay in money was 30 days longer than the longest delay on any other outcome.

Unlike Experiment 1, money was specified before the outcome when options were described. This avoided confusion about whether the money amount was risky or certain, which could have arisen if the phrasing had been reversed (stating "50% chance of X plus $Y"). The money amounts were the same as for Experiment 1. Uncompensated outcomes were always accompanied by an explicit $0.

In place of the intertemporal choice questions from Kirby et al. (1999), we included the no-loss framed risk preference task introduced in Eckel and Grossman (2002). This task involves participants selecting one gamble from a table of five options that increase down the table both in their expected value and in their spread. The higher the row number of the selected gamble, the greater the implied risk tolerance of the participant.

We also included two self-report questions that elicited participants' subjective estimates of the importance of risk to their decisions, as well as how important they considered risk relative to what the options were. The analysis of these responses is also presented in Data S3, and again these results suggest that the self-report questions are not capturing much of importance.

4.2 | Results

Our coding of signed compensation and consistency scores paralleled Experiment 1, the only difference being that negative signed compensation now indicates that the risky option was preferred. Just as in Experiment 1, most participants made choices fully consistent with a single signed compensation (76.4% in cross-modal and 69.2% in uni-modal). Overall, there was even greater consistency in Experiment 2 than in Experiment 1. Figure 8 shows the distribution of consistency scores for Experiment 2.

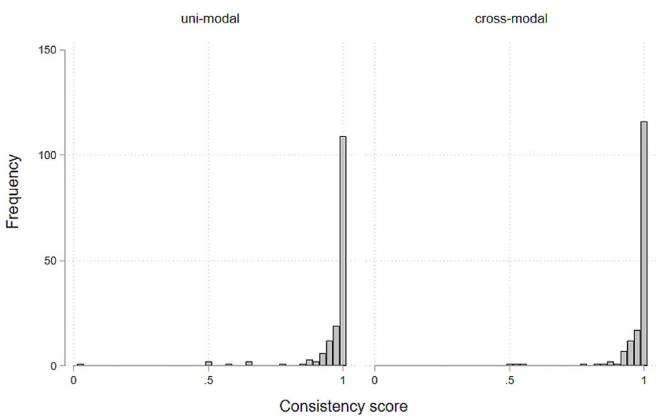

FIGURE 8 Histograms of consistency scores in Experiment 2, with the left panel showing uni-modal and the right panel showing cross-modal observations.

Again, we excluded outliers with consistency scores lower than 0.5. This resulted in the exclusion of one observation, from the uni-modal condition. We present the results of analysis with a 0.9 cut-off in Data S5. As with Experiment 1, Figure 8 shows that differences between uni-modal and cross-modal conditions in consistency scores are minimal.

Mean signed compensation was $6.10 (uni-modal, 95% CI [$4.51, $7.69]) and $1.33 (cross-modal, 95% CI [−$0.289, $2.949])—corresponding medians were $3.50 and $0.25. As predicted by attentional dilution, signed compensation was significantly higher in the uni-modal condition. Figure 9 presents these means and CIs along with their difference. Cohen's *d* was .465.

Table 2 presents regression analyses. We conducted a simple OLS regression (model 1) which shows that, on average, signed compensation was $4.77 lower for cross-modal than uni-modal decisions. As in Experiment 1, the CI for the difference estimate excludes zero, providing convincing evidence for an attentional dilution effect for risk. Models 2, 3a, and 3b introduced the selected prospect from Eckel and Grossman (2002), whereby higher scores indicate greater risk tolerance. Models 3a and 3b restrict the sample to uni-modal and cross-modal choices, respectively, and show that risk preferences measured in the Eckel–Grossman tasks do not explain signed compensation demanded either in our uni-modal or our cross-modal task. While we may have expected a relationship between risk preferences as measured by the Eckel and Grossman risk preference task and uni-modal signed compensation, the absence of any significant relationship between the risk preference task and cross-modal signed compensation is as expected. Subsequent research could address whether other measures of risk attitude display the anticipated relationship with signed compensation in the uni-modal case.

The regression results suggest the cross-modal effect and hence the attentional dilution effect are both strong when the modifier is risk, just as when it is delay.

DISCUSSION

We found that the two modifiers delay and risk had a smaller impact on compensation when decisions were cross-modal than when they were uni-modal, meaning their impact was suppressed when the tasks involved delay or risk to the delivery of different goods, rather than to the delivery of the same good. The findings were predicted by 'attentional dilution' according to which the decision weight of an attribute (and hence its impact on compensation) is a function of the attention paid to option attributes, including but not limited to time and risk. This attention, in turn, is a function of whether other attributes also differ between options.

One implication of this conclusion is that we should be cautious of general inferences about risk attitudes or time preferences from decisions in experimental settings involving a single commodity, whether they involve trade-offs among outcomes that differ in delay or probability of occurrence. Indeed, standard approaches to measuring risk attitudes or delay discounting functions are likely to inflate

FIGURE 9 Mean signed compensation for uni-modal and cross-modal risky comparisons and their differences with 95% confidence intervals. Experiment 2. *Note*: confidence interval for the difference calculated using Satterthwaite-corrected pooled standard errors.

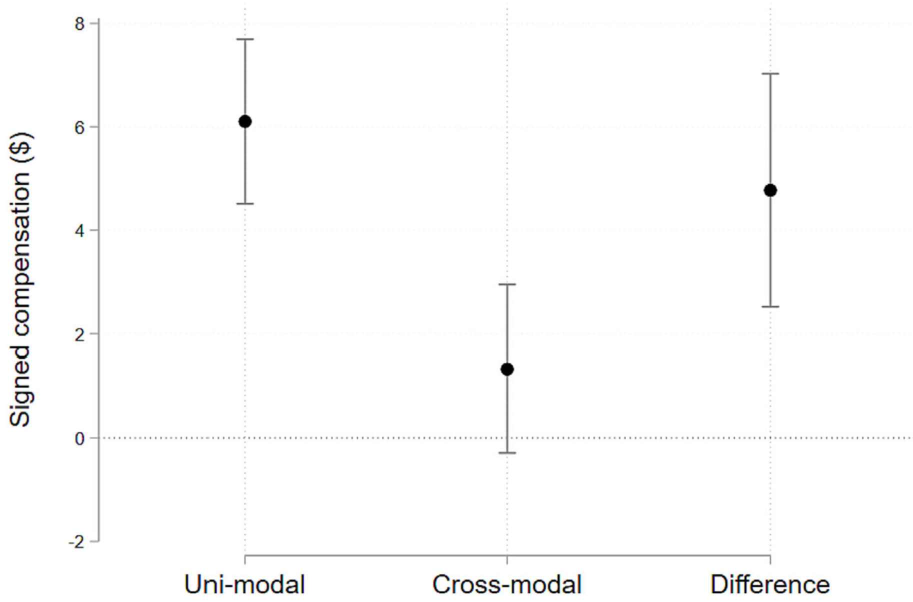

TABLE 2 Regression results for Experiment 2.

Signed compensation ($)	Model 1	Model 2	Model 3a (uni-modal)	Model 3b (cross-modal)
Cross-modal	−4.772***	−4.755***		
	[−7.033, −2.510]	[−7.008, −2.503]		
Risk preference task		0.764	1.100	0.458
		[−0.0309, 1.560]	[−0.0344, 2.235]	[−0.667, 1.583]
Constant	6.102***	4.196**	3.359*	0.199
	[4.495, 7.708]	[1.647, 6.744]	[0.119, 6.598]	[−3.020, 3.418]
Observations	319	319	158	161
R^2	.052	.062	.023	.004

Note: 95% confidence intervals in parentheses.
****p* < .001, ***p* < .01, and **p* < .05.

the importance of these modifiers, since they isolate the modifiers to obtain "clean" measures of effects. A second implication is that since the proposed mechanism of attentional dilution generalizes beyond the (sizeable) domains of risky and delayed gains, it may produce analogous effects for other modifiers such as social distance, or indeed for any other attribute. We predict that in general attributes will have a smaller effect on the evaluation of differences between options when the options vary by several attributes rather than by only one.

It is important to emphasize that we are not merely arguing that in cross-modal decisions the effects of delay and risk can be overridden by other considerations, but that these effects are literally smaller in cross-modal decisions. This is why measures like compensation—which assess the strength and not only the ranking of preference—are an essential part of our method. Our finding is that cross-modal evaluations increase patience and risk tolerance, and not merely that they make them harder to detect. We have made this point already, but it is worth underlining. No one would be surprised if, in a choice between a moped now and a BMW car in 1 year (or a moped now and a 50% chance of a BMW now), many people would choose the car simply because its greater value to them strongly outweighs the disadvantages of delay (or risk). This could be true even if the effects of delay and risk were *amplified* by the cross-modal comparison since they would still be overwhelmed by the massive difference between the outcomes. What we are suggesting instead is that the timing and risk of the car might be almost ignored in this comparison, whereas they would not be if the comparison involved the same two cars or two mopeds. They would be ignored because BMW cars are different than mopeds, and not because they are better.

Only through measures like compensation can we assess whether the effects of modifications are reduced, rather than merely rendered undetectable, in a cross-modal comparison. In the moped/BMW comparison, we would isolate the effect of the modification by comparing compensations for the four comparisons of the type used in this paper: That is, moped → modified BMW, BMW → modified moped, moped → modified moped, and BMW → modified BMW. Regardless of whether there is an attentional dilution effect, in a direct choice, we would expect the BMW (modified or not) to always be chosen over the moped (modified or not) because BMWs are so much more valuable than mopeds. But by measuring all four compensations and analyzing them as we do in this paper, we would find that the modification has a smaller effect on the cross-modal comparisons than on the uni-modal ones. Our method (and theory) concerns differences between options measured on a cardinal scale, and not merely on their ordering.

While we argued that a value-based approach cannot readily account for our results. It would be going too far to say that no value-based model could be created that would do so, although we have not been able to devise a *plausible* candidate. As mentioned earlier, we could predict the direction of some of our results if utility were convex in money, but this is implausible because there is very little evidence for such convexity, especially in the domain of monetary gains. Moreover, in formulating a general value-based theory, we implicitly assumed that value differences are unchanged by the presence of compensation. Again, alternatives are logically possible, such as those involving wealth and income effects, but these are likely to be trivial in our experiments because of the small amounts of money involved. In addition, the DCM's use of *delayed* compensation implies that (in the absence of borrowing) any income effect would violate additive separability across time, because the compensations occur later than the receipt of any goods. The majority of value-based models would therefore rule this out. Any value-based model consistent with our findings is in consequence likely to depend on ad hoc and/or implausible assumptions. Attentional dilution is both more parsimonious and intuitively compelling.

The attentional dilution effect is only one way that the impact on decisions of an attribute or dimension can vary as a function of choice context. It shares some resemblance, and possibly underlying mechanisms, to other context effects in choice and evaluation where changing which comparisons are made leads to corresponding changes in valuation. A famous example is the effect of joint versus separate evaluation, in which the weight put on an attribute depends on how easy it is to assess the significance of that attribute in the absence of comparison with other levels of that attribute ("evaluability"), and on opportunities to compare that attribute across options (joint evaluation) (see Hsee et al., 1999; Sevdalis & Harvey, 2006). Many studies show that attributes of low evaluability increase in weight in joint evaluation, especially if they are "justifiable," meaning the agent agrees that the attributes should matter (Li & Hsee, 2019). Another related effect concerns the influence of alignable versus non-alignable attributes in choice and valuation (e.g., Markman & Medin, 1995). In binary choice, an alignable attribute is one that is found in both options, while a non-alignable attribute is found in only one. The modifications we focused on are inherently alignable—every option is delayed (even if the delay is zero) and available with some risk (again, even if that risk is zero). The remaining features that differentiate the goods in our study are not easily aligned, and this might make comparisons more difficult and might well influence attentional dilution effects—although the direction of this influence is unclear. When comparing options, the same attributes have more weight if they are presented as aligned (with both options having the attribute) than if they are not (Hafner et al., 2020). This points out that, in addition to the number of attributes that differ between options, *how* they differ is likely to be an important determinant of preference.

Our empirical work tested some basic predictions of our proposed mechanism, but there is much more to do, and our approach generates a wide range of predictions. One obvious question concerns the impact of modifiers on cross-modal and uni-modal evaluations when the outcomes are losses instead of gains. In many situations, people must choose between negative outcomes or experiences. They have to pay bills, undergo painful treatments, or deal with embarrassing and difficult conversations. It is well established that there are systematic differences between the treatment of negative and positive outcomes. The effect of delay is perhaps the most noteworthy one. Although standard theories of discounting propose that given identical losses, people will want to delay those losses, it turns out they often prefer not to. They want to take the losses as soon as possible. This is true for negative experiences such as electric shocks or bee stings (Loewenstein, 1987; Sun et al., 2022), but even for monetary payments (Hardisty et al., 2013; Hardisty & Weber, 2020; Yates & Watts, 1975). To a rough approximation, if we hold outcomes constant, approximately 50% of people will choose to take negative outcomes sooner, and 50% will choose to take them later.

One implication of our model is that both the desire to delay *and* to accelerate options will be muted in cross-modal decisions. Just as in our analysis of gains, the attention that would be paid to time will now, at least in part, be paid to other differences between options, so that individual differences in preferences for the timing of negative outcomes will be reduced. We can illustrate this with one case. A well-supported explanation for the unwillingness to wait for negative experiences, such as bee stings and electric shocks, is anticipated dread (Loewenstein, 1987). Our view is that anticipated dread will have its greatest effects when there is a choice between a bad outcome early and the same or very similar bad outcome later. If you are going to get a root canal anyway, why not get it now? But when the trade-off involves different kinds of outcomes, such as an extraction now or a root canal later, those differences will reduce, although not eliminate, the role played by anticipation. The more different the outcomes, the greater this reduction. If it could be done, a choice between an embarrassing experience now and a root canal later would reduce the weight put on the anticipated dread of the root canal.

In our research, we held constant the goods to be traded off in uni-modal discounting. This was in part to allow for comparability across studies (i.e., we used the same goods as in Cubitt et al., 2018), but also to maximize the opportunity for a cross-modal effect to occur. However, often choices are between options that serve the same function, but are available at different times or with different risks. For instance, should you buy a house now, or wait until you have accumulated a bigger deposit to allow you to get a better house? Or do you take a job that you can have with certainty, or do you hold out for a better job that might not come to pass? These are important life decisions, and our view is that we cannot predict what decision will be made by assigning a value to the outcomes, and then discounting those values based on whether they are delayed or risky. We will have to consider how similar the outcomes are, and the more differences between them, the lower the weight put on time or risk or indeed any attribute at all.

Consider as a concluding example the implications of attentional dilution for the value placed on workplace risk. Imagine someone choosing between otherwise identical overseas construction jobs under different regulatory regimes, where the permissible risk of injury or death is greater in one regime than the other. In that uni-modal decision, the marginal increase in risk in the second regime will be a crucial factor, and may well entirely determine any compensation required to take a job under that regime. Now imagine the person choosing between (for example) a catering job in the "safe" regime versus a construction job in the risky one. We can describe the difference between the two jobs now as comprising two components: (a) the difference between catering and construction in the safe regime and (b) the difference between the risks between the two regimes. Our view is that in the second decision component (b) will receive less weight than in the first (and may even be disregarded entirely). In other words, if we consider the wage difference required to accept (b), it would be much larger in the first (uni-modal) decision than the second (cross-modal) one. Effects like these are unlikely to be observed in classical studies of the value of risk.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in https://osf.io/vqryx/?view_only=04d6a6b9eef04510848e778bf1defdba. In addition, this location includes all code needed to reproduce the analyses and raw data files.

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REFERENCES

Armstrong, W. (1939). The determinateness of the utility function. *Economic Journal*, *49*, 453–467. https://doi.org/10.2307/2224802

Bell, D. E. (1982). Regret in decision making under uncertainty. *Operations Research*, *30*(5), 961–981. https://doi.org/10.1287/opre.30.5.961

Bordalo, P., Gennaioli, N., & Shleifer, A. (2012). Salience theory of choice under risk. *Quarterly Journal of Economics*, *127*(3), 1243–1285. https://doi.org/10.1093/qje/qjs018

Bordalo, P., Gennaioli, N., & Shleifer, A. (2013). Salience and consumer choice. *Journal of Political Economy*, *121*(5), 803–843. https://doi.org/10.1086/673885

Craik, F. I. M. (2020). Remembering: An activity of mind and brain. *Annual Review of Psychology*, *71*, 1–24. https://doi.org/10.1146/annurev-psych-010419-051027

Cubitt, R., McDonald, R., & Read, D. (2018). Time matters less when outcomes differ: Unimodal vs. cross-modal comparisons in intertemporal choice. *Management Science*, *64*(2), 873–887. https://doi.org/10.1287/mnsc.2016.2613

Eckel, C. C., & Grossman, P. J. (2002). Sex differences and statistical stereotyping in attitudes toward financial risk. *Evolution and Human Behavior*, *23*(4), 281–295. https://doi.org/10.1016/S1090-5138(02)00097-1

Fisher, I. (1930). *Theory of interest, as determined by impatience to spend income and opportunity to invest it*. Macmillan.

Hafner, R. J., Elmes, D., & Read, D. (2020). Exploring the role of alignability effects in promoting uptake of energy-efficient technologies. *Journal of Experimental Psychology: Applied*, *26*(2), 300–311. https://doi.org/10.1037/xap0000253

Hardisty, D. J., Appelt, K. C., & Weber, E. U. (2013). Good or bad, we want it now: Fixed-cost present bias for gains and losses explains magnitude asymmetries in intertemporal choice. *Journal of Behavioral Decision Making*, *26*(4), 348–361. https://doi.org/10.1002/bdm.1771

Hardisty, D. J., & Weber, E. U. (2020). Impatience and savoring vs. dread: Asymmetries in anticipation explain consumer time preferences for positive vs. negative events. *Journal of Consumer Psychology*, *30*(4), 598–613. https://doi.org/10.1002/jcpy.1169

Houston, D. A., & Sherman, S. J. (1995). Cancellation and focus: The role of shared and unique features in the choice process. *Journal of Experimental Social Psychology*, *31*(4), 357–378. https://doi.org/10.1006/jesp.1995.1016

Houston, D. A., Sherrill-Mittleman, D., & Weeks, M. (2001). The enhancement of feature salience in dichotomous choice dilemmas. In E. U. Weber, J. Baron, & G. Loomes (Eds.), *Cambridge series on judgement and decision making. Conflict and tradeoffs in decision making* (pp. 65–85). Cambridge University Press.

Hsee, C. K., Loewenstein, G. F., Blount, S., & Bazerman, M. H. (1999). Preference reversals between joint and separate evaluations of options: A review and theoretical analysis. *Psychological Bulletin*, *125*(5), 576–590. https://doi.org/10.1037/0033-2909.125.5.576

Kahneman, D. (1973). *Attention and effort*. Prentice-Hall.

Kalenscher, T., & Pennartz, C. M. (2011). Do intransitive choices reflect genuinely context-dependent preferences? In M. R. Delgado, E. A. Phelps, & T. W. Robbins (Eds.), *Attention and performance 23: Decision making, affect and learning* (pp. 101–122). Oxford University Press.

Kirby, K. N., Petry, N. M., & Bickel, W. K. (1999). Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *Journal of Experimental Psychology: General*, *128*(1), 78–87. https://doi.org/10.1037/0096-3445.128.1.78

Kôszegi, B., & Szeidl, A. (2013). A model of focusing in economic choice. *The Quarterly Journal of Economics*, *128*(1), 53–104. https://doi.org/10.1093/qje/qjs049

Lehrer, K., & Wagner, C. (1985). Intransitive indifference: The semi-order problem. *Synthese*, *65*, 249–256. https://doi.org/10.1007/BF00869302

Li, X., & Hsee, C. K. (2019). Beyond preference reversal: Distinguishing justifiability from evaluability in joint versus single evaluations. *Organizational Behavior and Human Decision Processes*, *153*, 63–74. https://doi.org/10.1016/j.obhdp.2019.04.007

Loewenstein, G. (1987). Anticipation and the valuation of delayed consumption. *The Economic Journal*, *97*(387), 666–684. https://doi.org/10.2307/2232929

Loewenstein, G., & Prelec, D. (1992). Anomalies in intertemporal choice: Evidence and an interpretation. *The Quarterly Journal of Economics*, *107*(2), 573–597. https://doi.org/10.2307/2118482

Loewenstein, G. F., & Prelec, D. (1993). Preferences for sequences of outcomes. *Psychological Review*, *100*(1), 91–108. https://doi.org/10.1037/0033-295X.100.1.91

Loomes, G., & Sugden, R. (1982). Regret theory: An alternative theory of rational choice under uncertainty. *The Economic Journal*, *92*(368), 805–824. https://doi.org/10.2307/2232669

Luce, R. D. (1956). Semiorders and a theory of utility discrimination. *Econometrica*, *24*(2), 178. https://doi.org/10.2307/1905751

Luce, R. D., & Suppes, P. (1965). Preference, utility, and subjective utility. In *Handbook of mathematical psychology III* (pp. 249–409). Wiley.

Luckman, A., Donkin, C., & Newell, B. R. (2020). An evaluation and comparison of models of risky intertemporal choice. *Psychological Review*, *127*(6), 1097–1138. https://doi.org/10.1037/rev0000223

Magen, E., Dweck, C. S., & Gross, J. J. (2008). The hidden zero effect: A single choice as an extended sequence reduces impulsive choice.

Psychological Science, *19*(7), 648–649. https://doi.org/10.1111/j.1467-9280.2008.02137.x
Markman, A. B., & Medin, D. L. (1995). Similarity and alignment in choice. *Organizational Behavior and Human Decision Processes*, *63*, 117–130. https://doi.org/10.1006/obhd.1995.1067
Marzilli Ericson, K. M., White, J. M., Laibson, D., & Cohen, J. D. (2015). Money earlier or later? Simple heuristics explain intertemporal choices better than delay discounting does. *Psychological Science*, *26*(6), 826–833. https://doi.org/10.1177/0956797615572232
Mellers, B. A., & Biagini, K. (1994). Similarity and choice. *Psychological Review*, *101*(3), 505–518. https://doi.org/10.1037/0033-295X.101.3.505
Noguchi, T., & Stewart, N. (2014). In the attraction, compromise, and similarity effects, alternatives are repeatedly compared in pairs on single dimensions. *Cognition*, *132*(1), 44–56. https://doi.org/10.1016/j.cognition.2014.03.006
Prelec, D., & Loewenstein, G. F. (1991). Decision making over time and under uncertainty: A common approach. *Management Science*, *37*, 770–786. https://doi.org/10.1287/mnsc.37.7.770
Read, D., Olivola, C. Y., & Hardisty, D. J. (2016). The value of nothing: Asymmetric attention to opportunity costs drives intertemporal decision making. *Management Science*, *63*(12), 4277–4297. https://doi.org/10.1287/mnsc.2016.2547
Russo, J. E., & Dosher, B. A. (1988). Strategies for multiattribute binary choice. *Journal of Experimental Psychology. Learning, Memory, and Cognition*, *9*, 676–696.
Scholten, M., & Read, D. (2010). The psychology of intertemporal tradeoffs. *Psychological Review*, *117*(3), 925–944. https://doi.org/10.1037/a0019619
Sevdalis, N., & Harvey, N. (2006). Determinants of willingness to pay in separate and joint evaluations of options: Context matters. *Journal of Economic Psychology*, *27*(3), 377–385. https://doi.org/10.1016/j.joep.2005.07.001
Simonson, I. (1989). Choice based on reasons: The case of attraction and compromise effects. *Journal of Consumer Research*, *16*(2), 158–174. https://doi.org/10.1086/209205
Sun, H. Y., Ma, J. T., Zhou, L., Jiang, C. M., & Li, S. (2022). Waiting is painful: The impact of anticipated dread on negative discounting in the loss domain. *Judgment and Decision Making*, *17*(6), 1353–1378. https://doi.org/10.1017/S1930297500009451
Tversky, A. (1972). Elimination by aspects: A theory of choice. *Psychological Review*, *79*(4), 281–299. https://doi.org/10.1037/h0032955
Tversky, A. (1977). Features of similarity. *Psychological Review*, *84*(4), 327–352. https://doi.org/10.1037/0033-295X.84.4.327
Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, *5*(4), 297–323. https://doi.org/10.1007/BF00122574
Tversky, A., & Russo, J. E. (1969). Substitutability and similarity in binary choices. *Journal of Mathematical Psychology*, *6*(1), 1–12. https://doi.org/10.1016/0022-2496(69)90027-3
Weber, E. U., & Johnson, E. J. (2009). Mindful judgment and decision making. *Annual Review of Psychology*, *60*, 53–85. https://doi.org/10.1146/annurev.psych.60.110707.163633
Yates, J. F., & Watts, R. A. (1975). Preferences for deferred losses. *Organizational Behavior and Human Performance*, *13*(2), 294–306. https://doi.org/10.1016/0030-5073(75)90051-3

SUPPORTING INFORMATION

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