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When and why framing effects are neither errors nor mistakes

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Abstract
Framing effects play a central role in the debate regarding human rationality. They violate the normative principle of *description invariance*, which states that merely redescribing options or outcomes in equivalent ways should not affect judgments or decisions. Description invariance is considered by many decision researchers to be "normatively unassailable", and violations are widely regarded as demonstrations of systematic irrationality. This article develops an alternative perspective on invariance violations, applying Funder's (1987) distinction between "errors" and "mistakes". Description invariance implicitly assumes that (1) rational preferences must be complete and (2) frames do not convey choice-relevant information. We argue that both assumptions often do not hold. When they fail, framing effects in the laboratory are not "errors", and they do not provide evidence for "mistakes" in natural environments. Furthermore, recent findings suggest that participants often do not regard different responses to different frames as unreasonable, and presenting them with arguments for and against description invariance has little effect on their views. Finally, we argue that similar lessons generalize to other coherence norms, such as procedure invariance and independence of irrelevant alternatives.

Keywords Framing effects · Description invariance · Rationality · Incomplete preferences · Information leakage

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Framing effects occur when equivalent redescriptions of events or objects influence judgments and choices. Researchers study framing effects primarily using two types of tasks – *attribute framing* and *risky choice framing* (Levin et al. 1998). In an attribute framing experiment, participants evaluate a single object or event described on a single dimension. One pole of the dimension is positive (e.g., a medical treatment's survival rate) and the other negative (the treatment's mortality rate), and a given point on the dimension is described in terms of one pole or the other (e.g., "85% survival rate" vs. "15% mortality rate"; see Table 1). The standard finding in attribute framing studies has been termed the "valence-consistent shift": Participants' evaluations of the object or event are more positive when the frame is positive rather than negative (Levin et al. 1998). The treatment leading to an "85% survival rate" receives better ratings than the treatment that leads to a "15% mortality rate".

Risky choice framing tasks are more complex. Here, the participant makes a choice between two options that yield different outcomes with different probabilities, and outcomes are framed in terms of either gains or losses. The problem usually pits a certain option against a risky option with the same expected value (Tversky and Kahneman 1981; see Table 2). In these studies, risk attitudes are typically found to differ depending on the framing of the problem. Participants are more risk-averse (i.e., more likely to choose the certain option) when both options are framed in terms of gains than when both options are framed in terms of losses. In Table 2, for example, participants tend to choose Program A over Program B in the gain frame, but tend to choose Program D over Program C in the loss frame, despite the fact that objective outcomes and probabilities are held constant across the two frames. In short, the framing of alternatives systematically affects decisions: In attribute framing, positive frames lead to more positive evaluations; and in risky choice framing, the gain frame leads to more risk-averse choices.[1]

Framing effects are not only interesting from a psychological perspective. They also play a central role in the debate regarding human rationality. Framing effects violate *description invariance*, which states that merely reframing an option or event in equivalent ways ought not affect one's choices and judgments. This coherence principle is widely regarded as "normatively unassailable" (Tversky et al. 1990, p. 214). Indeed, based largely on risky choice framing effects, Tversky and Kahneman (1986) concluded that "no theory of choice can be both normatively adequate and descriptively accurate" (p. S251). That is, because framing effects are robust, any descriptive theory must accommodate them, but because framing effects could presumably never be rationally justified, no normative theory could allow them.

In this article, we evaluate the normative implications of framing effects, both in the laboratory and beyond. To help navigate this terrain, we make use of Funder's (1987) distinction between "errors" and "mistakes". Errors are violations of normative models using experimenter-constructed stimuli, which may not be representative of the natural environment. Mistakes, by contrast, occur in the real world under natu-

[1] There are, however, noteworthy moderators of risky choice framing effects. For example, framing effects on risk preferences change when relevant outcomes have low probabilities (Kahneman & Tversky 1979) or when they are represented on a proportional (e.g., percentage of lives saved) rather than an absolute (e.g., number of lives saved) numerical scale (Müller-Trede et al. 2018).

Table 1 Example of an attribute framing scenario (Leong et al. 2017)

(Survive frame)
Imagine a rare disease that leads to many unpleasant symptoms and can even cause death. The method by which this disease is contracted has been studied, but scientists have yet to identify the exact cause. For the past 20 years, the same treatment has been used in patients with the disease. A new experimental treatment has been tested, and it has several advantages and disadvantages. In terms of outcome, 85% of patients undergoing this new treatment survive at least 5 years.
(Die frame)
Imagine a rare disease that leads to many unpleasant symptoms and can even cause death. The method by which this disease is contracted has been studied, but scientists have yet to identify the exact cause. For the past 20 years, the same treatment has been used in patients with the disease. A new experimental treatment has been tested, and it has several advantages and disadvantages. In terms of outcome, 15% of patients undergoing this new treatment die within 5 years.

Table 2 Example of a risky choice framing scenario (Tversky and Kahneman 1981)

Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences are as follows:
(Gain frame)
If Program A is adopted, 200 people will be saved
If Program B is adopted, there is a 1/3 probability that 600 people will be saved and a 2/3 probability that no people will be saved
(Loss frame)
If Program C is adopted, 400 people will die
If Program D is adopted, there is a 1/3 probability that nobody will die and a 2/3 probability that 600 people will die

rally occurring conditions and are consequential. The distinction is important because errors do not necessarily imply mistakes, though it is often assumed that they do. That is, the observation that people violate a rational norm in a contrived laboratory experiment does not establish that they will perform poorly in their natural environment. Errors can reveal important information about the process used by participants to perform a task, but they do not tell us whether this process is ecologically adaptive. Funder illustrates the distinction using 2D visual illusions, such as the Ponzo and Müller-Lyer illusions (Gregory 1971). As an example, consider the two tables in Fig. 1 (Shepard 1990). People perceive the tabletop on the left to be longer and narrower than the tabletop on the right, even though the two tabletops have the same dimensions in the 2D illustration. This error occurs, however, because the visual system is using cues in the 2D image that are useful in our natural 3D world for inferring depth. These cues suggest that the left table extends farther into the distance. But if it projects a fixed light pattern onto the retina, a more distant source must be larger. That is, if these images were projected to the retina, not from a drawing on a page but from real objects in the 3D world, the table on the left would very likely be longer. The error in the laboratory using 2D stimuli does not imply that people make mistakes in their 3D world (McKenzie et al. 2018).[2]

[2] Not only do errors not imply mistakes, but avoiding errors does not imply avoiding mistakes. Fine et al. (2003) discovered a patient who does not experience the Shepard tables illusion: The patient was blinded

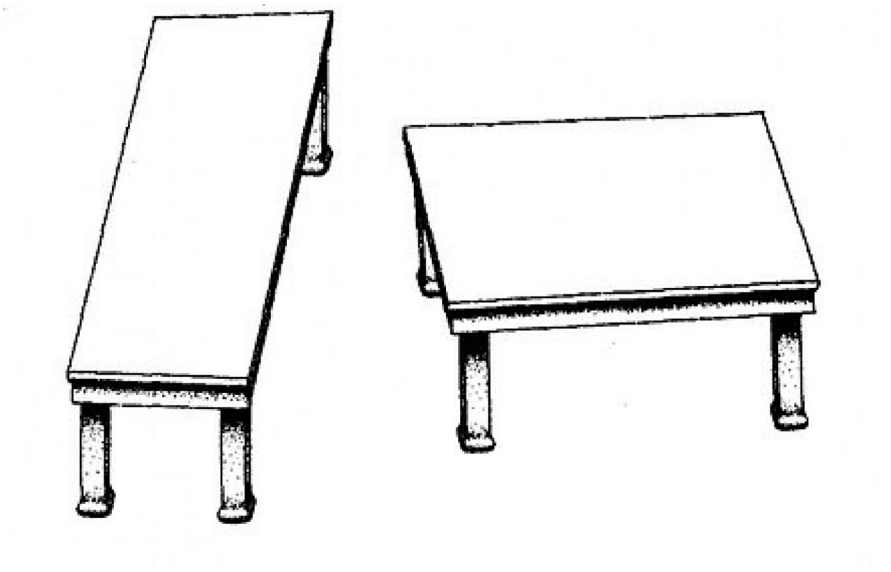

Fig. 1 Shepard tables

Whereas Funder (1987) used the distinction between errors and mistakes to argue that laboratory errors do not imply mistakes in our natural environment, we will argue that typical framing effects are neither errors nor mistakes. They are not errors because description invariance – the normative principle that framing effects are said to violate – depends on two implicit assumptions: that (1) rational preferences are complete, and (2) frames do not convey distinct choice-relevant information. We argue that both assumptions are often violated. When rational preferences are incomplete, there need not be a unique best option, rendering framing effects nondiagnostic with respect to rationality; and when frames "leak" choice-relevant information, it may be irrational *not* to exhibit a framing effect. Moreover, while description invariance has sometimes been justified on the grounds that most participants *want* their choices to conform to the principle, empirical studies cast doubt on this claim. Finally, we argue that framing effects are not typically mistakes either, again for two reasons: People's goals and values are not resolved to infinite precision and do not generally entail a complete ordering of all possible acts; and frames leak information due to empirical patterns of frame-selection in natural discourse.

at age 3 and had his vision restored through surgery 40 years later. This long-term visual deprivation led to lasting visual deficits, making it difficult for him to interpret (2D) retinal images in 3D. Not experiencing these 2D illusions (i.e., errors) is a sign of a dysfunctional visual system (which leads to mistakes).

1 When and why framing effects are not errors

As mentioned, framing effects are considered irrational – i.e., errors – because they violate the normative principle of description invariance. According to this principle, equivalent descriptions of options should result in identical choices and evaluations. Although description invariance has traditionally been seen by researchers as "normatively unassailable", its normative validity depends on two critical implicit assumptions: (1) rational preferences must be complete; and (2) frames must not "leak" distinct choice-relevant information (Sher and McKenzie 2011; Sher et al. 2025a). But as we explain below, these assumptions often do not hold, with important implications for the rationality of framing effects.

1.1 Preferences are often incomplete

An implicit assumption underlying the normative validity of description invariance is that, from the perspective of a rational decision maker (DM), exactly one of the available options is best (e.g., either the risky option or the sure thing in Table 2). This assumption traces back to two axioms of Expected Utility Theory (EUT; von Neumann and Morgenstern 1944) – the axioms of *transitivity* and *completeness*. Transitivity rules out preference loops. It states that whenever an option a is preferred to another option b ($a \succcurlyeq b$), and b is preferred to a third option c ($b \succcurlyeq c$), then a is also preferred to c ($a \succcurlyeq c$). The completeness axiom, though seemingly straightforward, turns out to be more problematic. It states that the ranking of alternatives is always well-defined. That is, for any pair, a, b, of options, either a is strictly preferred to b ($a \succ b$), b is strictly preferred to a ($b \succ a$), or the DM is precisely indifferent between a and b ($a \sim b$).

Importantly, indifference is a "knife's-edge" relation of exact subjective equality. That is, if $a \sim b$, and if a is ever-so-slightly improved to yield a sweetened option $a^+ \succ a$, then also $a^+ \succ b$. If a DM's preferences are transitive and complete, the knife's-edge character of indifference means that, in a finite set of complex alternatives, there will generally be a *unique* best option. This is because it is very unlikely that an arbitrary pair of options will happen to satisfy the knife's-edge condition of perfect subjective balance (Sher et al. 2025a).[3] Assuming that frames provide no relevant information (and hence would not modify a rational DM's ranking of alternatives), it follows that a framing effect – in which different choices are made in different frame conditions – indicates that at least one choice is suboptimal.

However, unlike some other EUT axioms, such as transitivity and independence,[4] completeness is not a compelling normative principle (a point that some economists

[3] There is, however, one noteworthy exception to this rule. If (as in the problem in Table 1) the task is intentionally designed so that all options have equal expected value, then a rational DM with complete preferences who happens to be risk-neutral will be indifferent between all options. In this special case, any pattern of choice is permissible, and a framing effect would not indicate a failure of rationality, even with complete preferences.

[4] The independence axiom states, in essence, that if the DM prefers a to b, then the DM also prefers a gamble that offers some probability of a to a matched gamble that instead offers b with the same probability. Though some researchers have questioned the normative standing of transitivity and independence

have recognized; e.g., Aumann 1962; Sen 1997). It has the unreasonable implication, for example, that monetary indifference points for all goods must be defined to infinite precision (i.e., there must be a unique point-value x such that all values above \$$x$ are definitely preferred to the good and the good is definitely preferred to all values below \$$x$). There is no evidence that human DMs possess such precise indifference points, and no clear normative argument why they should. A theory of rational choice can neither dictate a DM's values nor the level of precision with which those values are defined.

Notably, economists have developed alternative models of rational choice that allow for incomplete preferences (e.g., Mandler 2005), and rejecting the completeness requirement immediately opens the door to rationally permissible framing effects (Sher et al. 2025a). Absence-of-preference, unlike indifference, is not a "knife's-edge" relation; it can be robust to marginal enhancement of either alternative. In the above example, a DM may lack a preference between a and b, while also lacking a preference between a^+ and b. Thus, when the ranking of alternatives is incomplete, a finite choice set may easily contain distinct alternatives, a, b, which are unranked relative to one another, and neither of which is outranked by any other option in the set. If a is chosen under one frame and b under another, then choices are frame-dependent but no choice is an error.

To sharpen the analysis of errors and mistakes, it is useful to introduce the notion of a *normative ranking* of alternatives. The normative ranking specifies what is better or worse in relation to the DM's interests (i.e., more or less in line with the values or goals to which the DM is committed). A DM's actual choices may sometimes stray from the normative ranking, either because of a failure of judgment (if the DM misjudges what best advances her goals) or because of a failure of self-control (if the DM fails to act in accord with her judgment of what is best). Any discussion of decision "mistakes," in Funder's (1987) sense, must assume the existence of a normative ranking, because questions of (in)accuracy arise only where there is a standard of accuracy. In other words, the analysis of mistakes turns on questions of "correspondence" (do choices lead to good real-world outcomes?) rather than "coherence" (are choices mututally consistent?; Hammond 2000), and thus presupposes a normative ranking of outcomes as better or worse. Reformulated in these terms, our contention is that, both in the laboratory and beyond, normative rankings can be – and indeed often are – incomplete.

Why may a DM's normative ranking be incomplete, and when may rational framing effects occur? Sher and McKenzie (2022) note that incomplete normative rankings may trace back to at least two distinct sources – value imprecision and value conflict. In value imprecision, the values to which the DM is committed are coarse-grained, and suffice to determine some but not all comparisons. For example, a hat may be valued somewhere between \$10 and \$20, with no precise monetary indifference point. Likewise, in a multi-attribute choice problem, the relative weights assigned to the attributes may be fuzzy (or even completely unspecified; Walasek and Brown 2023). For example, consider a DM who weights an attribute some-

(e.g., Allais 1953; Temkin 2012), significant substantive arguments have been advanced in defense of these axioms (e.g., Savage 1954).

where between twice and three times as heavily as a second attribute (i.e., so that a 1 unit improvement on the first attribute is judged as roughly equivalent to a 2–3 unit improvement on the second attribute). Letting (x, y) denote an item with scores of x and y on the two attributes, the DM's evaluative weights entail that (5, 5) is better than (4, 6), but entail no ranking of (5, 5) vs. (4, 7.5). In cases of value imprecision, incompleteness may require the DM to make purely arbitrary choices when the values to which the DM is committed provide no reason to choose either option over the other. Sher et al. (2025a) develop a rational analysis of such arbitrary decisions. The rational analysis allows for rational frame-dependence in decision making, for the reasons we have explained above: frame-dependence does not demonstrate that any choice is suboptimal. (Notably, the rational analysis also *requires* certain forms of history-dependence in decision making – and sheds surprising light on empirical phenomena such as status quo maintenance, the sunk cost effect, coherent arbitrariness, and attention to sunk costs.)

Cases of value conflict are more complex. Here, the DM endorses two schemes for evaluating alternatives when all else is equal, but has not committed to a principle that decides conflicts between them. These evaluation schemes, V_1 and V_2, may be represented by distinct preference orders, $\succcurlyeq_1$ and $\succcurlyeq_2$. (Note that these preference orders may themselves be incomplete, if there is value imprecision within an evaluation scheme.) Value conflict arises when $a \succ_1 b$ but $b \succ_2 a$. A canonical example comes from Sartre (1946/2007), who writes of a student attempting to resolve conflict between his sense of social duty (pushing him to leave the country to fight the Nazis) and his duties as a son (pushing him to stay home to support his mother).

Problems of value conflict have been addressed by a number of researchers (though they are not always formulated in the conceptual vocabulary we use here; cf. Levi 1986; Schick 1997). In a recent treatment, Bermúdez (2020, 2022) argues that rational choice in the face of conflict requires a kind of perspectival flexibility, in which the DM can enter into multiple evaluative perspectives, flexibly "frame" the problem from each viewpoint, and identify and think critically about what the perspectives share and how they differ. If value conflict remains unresolved, some framing effects – in which different frames activate different evaluative perspectives – may then reflect the DM's capacity for perspectival flexibility, which Bermúdez argues is an essential component of human rationality.

To be sure, the theory of rational choice under unresolved value conflict is hardly settled. And much work is needed to argue that any particular framing effect reflects the kind of perspectival flexibility that Bermúdez advocates. (Bermúdez 2020 applies the framework to problems of self-control, fairness, and cooperation, but he does not explain simple risky choice framing effects in this way.) Nonetheless, the developments we have reviewed – regarding incomplete normative rankings and the analysis of rationality in the face of value conflict – highlight the complex normative problems that lurk behind the seemingly simple principle of description invariance. When imprecise and conflicting value commitments give rise to incomplete normative rankings, invariance violations do not demonstrate errors.[5]

[5] This section has focused on sources of *normative incompleteness* – i.e., incompleteness in the normative ranking implied by the DM's value commitments and factual beliefs. Sher et al. (2025a) distinguish

1.2 Frames often "leak" Choice-Relevant information

We have seen that, when rational preferences are incomplete – owing to either value imprecision or value conflict – framing effects need not be counter-normative. Next, we argue that, even if completeness is assumed, framing effects are sometimes permitted, or even mandated, by a model of rational choice. While description invariance states that redescribing outcomes in equivalent ways ought not affect judgments and choices, researchers have used different definitions of "equivalent". The most stringent definition is logical equivalence: Frames are logically equivalent if the truth of one frame entails the truth of the other. For example, it is a necessary truth that a medical treatment leads to an 85% survival rate if and only if it leads to a 15% mortality rate. The logical content of the two frames is the same. Many examples of framing effects in the literature use logically equivalent frames.

However, Sher and McKenzie (2006) argued that, for a framing effect to be considered irrational, it is not sufficient that the frames in question be logically equivalent; instead, they must be *information equivalent*. That is, the frames must not communicate different choice- or judgment-relevant information. Clearly, it would not be irrational to respond differently to frames that communicate different information that is relevant to a choice or judgment.

It might seem that logically equivalent frames would necessarily be information equivalent, but that is not the case. This is because frames cannot be implanted in people's brains, but are instead typically communicated by "speakers" (e.g., doctors, policymakers, experimenters) to "listeners" (e.g., patients,, constituents, participants), and speakers tend not to choose randomly between frames. Although experiments with random assignment to frame condition render frames uninformative, speakers' frame selections in everyday conversation are influenced in predictable ways by background conditions, or context. Therefore, a speaker's *choice of frame* is generally informative with respect to those background conditions. For example, a speaker's choice to describe a medical treatment as leading to an "85% survival rate" (rather than a "15% mortality rate") may be affected by knowledge of such background conditions as the survival/mortality rates of other available treatments. The speaker's choice of frame then provides a signal regarding the background conditions. If the background conditions are relevant to the choice or judgment, then the frames in question are not information equivalent and a resulting framing effect need not be irrational. An ideally rational DM, with a full understanding of regularities in frame selection, would be responsive to choice-relevant information "leaked" from the speaker's choice of frame. In this case, a framing effect may be a consequence of, not a counter-example to, rationality.

For example, a 4-oz measuring cup with water at the 2-oz line could be described (i.e., framed) as either "half full" or "half empty". Although these frames are logically equivalent, speakers are more likely to describe a cup as "half empty" if it is

normative incompleteness from *epistemic incompleteness*, in which the best option, given the DM's values and beliefs, is well-defined in principle, but the DM, operating under information-processing capacity limits, is unable to identify it. Epistemic incompleteness may stem from other sources, such as imperfect or intractably complex information (cf. Page 2022; Chap. 8), and raises subtle normative challenges (Sher et al. 2025a).

perceived as relatively empty (e.g., it was previously full) than if it is perceived as relatively full (e.g., it was previously empty; McKenzie and Nelson 2003; see also Sher and McKenzie 2006). In this context, a speaker's choice of frame signals *relative abundance*: Describing the cup as "half empty" signals that the cup is *relatively empty*. Similarly, a speaker's decision to describe a medical treatment as leading to an "85% survival rate" (rather than a "15% mortality rate") provides evidence that the treatment leads to relatively many survivors, compared to standard treatments (see also Teigen and Karevold 2005).

In the above examples, information leaked from the choice of frame concerns the speaker's reference point (e.g., the cup is fuller than it was, or the new treatment leads to a higher survival rate than the standard treatment). Sher and McKenzie (2006) generalized the leakage of information to cases where frames signal a speaker's attitude: Speakers are more likely to select a positive attribute frame when they have a positive attitude toward the object or event. In other words, frame selection can leak not only the speaker's reference point, but also *implicit recommendations* (see also McKenzie et al. 2006) To establish this point, Sher and McKenzie made use of a framing study by Duchon et al. (1989), who showed that participants, playing the role of R&D supervisors, were more likely to allocate larger research budgets to an R&D team when it was described as having had 30 successful projects out of 50 rather than 20 unsuccessful projects out of 50. Might this valence-consistent shift occur because speakers are more likely to describe good teams in terms of their number of successes rather than their number of failures? Sher and McKenzie presented participants with a background description of an R&D team with either remarkably impressive or remarkably unimpressive members and achievements, and then asked them to describe the team's record to an R&D manager. Participants were more likely to describe the strong team in terms of its number of successes compared to the weak team. Because good teams are more likely to be described in positive terms, the choice of a positive frame signals the speaker's positive attitude towards the team.

1.3 Do participants think that framing effects are errors?

Other researchers have claimed that classic risky choice framing effects are not errors. Some have argued that the frames are not equivalent (i.e., description invariance does not hold) and that it is therefore not an error to respond differently to the frames. For example, Kühberger (1995) pointed out that the "sure thing" options in Table 2 are not fully described in the way that the risky options are, and when he presented participants with a full description of the sure thing option (e.g., "200 people will be saved and 400 people will not be saved"), the framing effect was eliminated. Mandel (2014) argued that the framing effect occurs because the natural interpretation of, e.g., "200 people will be saved" is "*at least* 200 people will be saved" (see also Jou et al. 1996). Geurts (2011) suggested that description invariance is not normative because it does not guarantee *semantic* equivalence – the frames might have very different meanings. If two phrases are synonymous (i.e., have the same meaning), then they should serve as substitutes in a sentence and not change the meaning of that sentence, but this is not the case for the sure thing options in Table 2: "It's good that [200 people will be saved]" and "It's good that [400 people will die]" are clearly not synonymous; in fact,

they seem contradictory. In each of these cases, researchers are claiming that risky choice framing effects are not errors: Either the frames are not description invariant, or description invariance is not the appropriate normative standard.[6]

In part because of controversy about whether risky-choice frames are "really" equivalent, Kahneman and Tversky opted to *defer to their participants* when it came to the issue of whether frames should be treated the same:

> [W]e eventually adopted a less theory-bound view of what makes two problems the same. It is the decision maker who should determine, after due consideration of both problems, whether the differences between them are sufficiently consequential to justify different choices. Violations of this lenient form of invariance demonstrate incoherence without a need for any judgment from on high about what is truly equivalent. (Kahneman 2000, p. xv)

Furthermore, Kahneman and Tversky (1984) suggested that participants do, in fact, wish to treat frames the same – i.e., they do not want to exhibit framing effects:

> The failure of invariance is both pervasive and robust. It is as common among sophisticated respondents as among naive ones, and it is not eliminated even when the same respondents answer both questions within a few minutes. Respondents confronted with their conflicting answers are typically puzzled. Even after rereading the problems, they still wish to be risk averse in the "lives saved" version; they wish to be risk seeking in the "lives lost" version; and *they also wish to obey invariance and give consistent answers in the two versions*. In their stubborn appeal, framing effects resemble perceptual illusions more than computational errors. (p. 343, italics added)

A passage from Kahneman's 2002 Nobel Prize biography makes the same point:

> The ease with which framing effects can be demonstrated reveals a fundamental limitation of the human mind. In a rational-agent model, the agent's mind functions just as she would like it to function. Framing effects violate that basic requirement: *the respondents who exhibit susceptibility to framing effects wish their minds were able to avoid them*. (italics added)

Despite the importance ascribed to participants' wishes to respond identically to the two frames, Kahneman and Tversky did not report any data regarding these wishes, just anecdotes. They did not report whether all participants were probed after the experiment(s) or how many participants thought that responding differently to the two frames was an error. However, Frisch (1993) reported that, of the participants who showed a (within-subject) framing effect on the Asian disease problem, the num-

[6] In our view, the force of these critiques is limited – because the pragmatic reading of the sure gain or loss as a lower bound does not seem plausible in risky choice framing effects with monetary gambles (e.g., Kahneman & Tversky 1979, Problems 11–12) and because the normative relevance of semantic non-equivalence (over and above information non-equivalence) is unclear. But these critiques illustrate the extent of controversy surrounding frame equivalence and rationality.

ber who subsequently reported that both frames should be treated the same ranged from 69% (Exp 1) to just 47% (Exp 2). A substantial proportion of her participants – 31% to 53% – did not consider their responding differently to the frames to be an error.

Thus, some researchers – and apparently also a good number of participants who exhibit framing effects – believe that the frames in question are not equivalent and/or that it is not an error to respond differently to the frames. While it is informative to get a baseline sense of whether participants consider framing effects to be errors, McKenzie, Liu, Sher, and Leong (in preparation) have taken a further step by presenting arguments for and against responding consistently to frames in order to see if this changes participants' behavior. Perhaps participants do not think that responding differently is an error when shown the different frames, but they do believe it to be an error after the principle of description invariance is explained to them. This approach is based on Slovic and Tversky's (1974) "understanding/acceptance principle" (which they attribute, in spirit, to Savage 1954), namely, that if a principle or model is truly rational, then deeper *understanding* of the principle will lead to greater *acceptance*. Presumably, no reasonable person who truly understands a normative principle would wish to violate it. To be sure, the understanding/acceptance principle may itself be questioned (after all, researchers who study these principles, and presumably understand them well, often disagree about their normative validity). Yet the principle opens up an interesting field of empirical inquiry: How widespread is acceptance of description invariance, with and without exposure to normative arguments?

Two of McKenzie et al.'s (in preparation) experiments examined whether participants thought that responding differently to attribute frames was an error. One experiment presented participants with a medical scenario in which a hypothetical patient learns about a new treatment for her illness and is deciding whether to undergo the treatment. Participants were told that the doctor could describe the treatment in terms of either its success rate (80% of patients cured) or its failure rate (20% of patients remain sick). To highlight the logical equivalence of the two frames, participants were also shown the treatment results in a pie chart. At issue was whether participants thought it would be a mistake for the patient to be influenced by how the doctor chose to describe the treatment results (80% cured vs. 20% remain sick), or whether it would be in the patient's best interest to be influenced. Before responding, participants were presented with either an argument for description invariance (why being influenced would be a mistake), an argument for information leakage (why being influenced would be in the patient's best interest), both arguments, or no additional information. The two arguments are shown in Table 3. Just over half of participants thought it would be in the patient's interest to be influenced by the doctor's frame, and there was no significant effect of argument(s).

A second experiment presented participants with an attribute framing task in which they responded to both frames, which described ground beef as either "85% lean" or "15% fat". After each frame, participants rated how fatty or lean they thought the beef was, relative to other ground beef on the market. As expected, the beef was rated as significantly leaner when it was described as "85% lean", and 45% of participants gave different ratings to the two frames. All participants were then presented with the two scenarios juxtaposed, told that they were identical except for the framing of

Table 3 Arguments for description invariance and for information leakage used in McKenzie et al.'s (in preparation) Experiment 1 on attribute framing

Description Invariance Argument
It would be a mistake for a patient to be influenced because the two descriptions convey exactly the same information about treatment outcomes.
If a treatment leads to 80% of patients being cured, then this means it leads to 20% of patients remaining sick, and vice versa. No matter what wording the doctor uses to describe the treatment, the objective outcome is the same.
Because all that matters is the objective information in the description, it would be a mistake to be influenced by which way the doctor describes the treatment outcome.
Information Leakage Argument
It would be in a patient's best interest to be influenced because speakers usually describe outcomes in negative terms when they consider them relatively bad.
For example, a speaker may describe a treatment in terms of the percentage who remain sick if it leads to more being sick than usual. The speaker's use of negative wording suggests the speaker has a negative view of the treatment.
Because the doctor's wording may convey their attitude, it would be in the patient's best interest to be influenced by which way the doctor describes the treatment outcome.

Table 4 Arguments for description invariance and for information leakage used in McKenzie et al.'s (in preparation) Experiment 2 on attribute framing

Description Invariance Argument
It is unreasonable for people to be influenced because the two descriptions convey exactly the same information about the ground beef. If the ground beef is 85% lean, then it is also 15% fat, and vice versa.
No matter what wording the speaker uses to describe the ground beef, the objective information is the same.
Because all that matters is the objective information in the description, it is unreasonable for people to be influenced by the way the speaker describes the ground beef.
Information Leakage Argument
It is reasonable for people to be influenced because speakers usually describe outcomes in terms of their characteristics (e.g., fatty or lean) that are relatively abundant.
For example, a speaker may describe the ground beef in terms of how fatty it is if its fat content is higher than other ground beef on the market. The speaker's description of the ground beef's percentage of fat therefore suggests that the speaker thinks it is fattier than other ground beef.
Because the speaker's wording may convey his/her beliefs, it is reasonable for people to be influenced by the way the speaker describes the ground beef.

the lean/fat content, and given the opportunity to change their lean/fatty responses. 15% of participants did so, with most changing their responses so that they were the same for the two frames. They were then asked to what extent they thought it was reasonable vs. unreasonable to rate the beef differently depending on the description, and the mean rating (4.7) was just below the midpoint (6) on the 11-point scale, indicating somewhat unreasonable. However, there was a large difference between the mean reasonableness ratings from those who initially did (6.4) vs. did not (3.3) exhibit a framing effect. Thus, on average, those who exhibited a framing effect viewed treating the frames differently as slightly reasonable, contrary to Kahneman's (2002) assertion that participants "who exhibit susceptibility to framing effects wish their minds were able to avoid them". Participants were then presented with both an argument for description invariance and an argument for information leakage (see Table 4), again had the opportunity to change their ratings of how lean/fatty the beef

is, and again rated the reasonableness of treating the frames differently. Only 2% changed their ratings of the beef, and reasonableness ratings *increased* from 4.7 to 5.4. For participants who initially rated the beef differently (i.e., showed a framing effect), their reasonableness ratings increased slightly from 6.4 to 6.6, and those who rated the beef the same increased their reasonableness ratings from 3.3 to 4.4. In short, presenting arguments for and against description invariance did not lead to greater acceptance of it; in fact, it led to slightly less acceptance. Of course, in studies of this kind, the size and direction of effects may depend on the exact wording of the arguments. While we tried to make both arguments clear and straightforward (see text in Tables 3 and 4), the results should thus be interpreted with caution. But taken together, these results cast doubt on the common assumption that participants in framing tasks would want their responses to satisfy description invariance.

The above two experiments used attribute frames. What about the risky choice framing tasks employed by Tversky and Kahneman (1981; cf. Table 1)? In a third experiment, McKenzie et al. (in preparation) presented participants with a slightly modified Asian disease risky choice framing task.[7] They read both frames sequentially and reported after each whether they preferred the sure thing or the risky option. There was a significant framing effect, with 71% selecting the sure thing in the gain frame, whereas only 55% did so in the loss frame. About 20% of participants showed a within-subjects framing effect. The two frames were then juxtaposed for participants, who were told that the scenarios were the same except for the framing of the outcomes. They rated how (un)reasonable (-3 to 3) it was to respond differently to the frames, and the overall mean (0.4) was just above the midpoint, indicating somewhat reasonable. As in the within-subjects attribute framing experiment above, those who exhibited a framing effect rated treating the frames differently as more reasonable than those who did not exhibit a framing effect (1.3 and 0.1, respectively).

Arguments for and against description invariance were then presented to participants. However, these arguments did not refer to information leakage (whose relevance to risky choice framing problems is not well-established).[8] Instead, the argument against description invariance appealed to incomplete preferences arising from value conflict, where the same problem can reasonably be viewed from multiple perspectives. The arguments for and against description invariance are shown in Table 5. Participants' ratings regarding the reasonableness of treating the frames differently were virtually unaffected by the two arguments; this was true for both those who did and did not show a framing effect.

[7] For this experiment, we only report data for the 53% of participants who correctly answered a relatively challenging comprehension question regarding the normative arguments.

[8] Information leakage occurs in myriad settings where speakers select among logically equivalent utterances. Beyond attribute framing, examples include active vs. passive sentence construction (Johnson-Laird 1968) and the choice of numerical vs. verbal labels (e.g., 6 vs. half dozen; Burson et al. 2009). But to explain a framing effect, it does not suffice to demonstrate information leakage. One must also show that the background conditions that (i) lead speakers to select a given frame also (ii) justify the choices listeners make when exposed to that frame. Such twin regularities in selection and reaction have not, to our knowledge, been established for risky choice frames (but see Sher and McKenzie 2008 for some suggestive findings). In these tasks, both the certain and risky options receive the same (gain or loss) frame. For an information leakage account to be viable, one would need to show how and why the selection of a *joint* "gain" frame leaks information that selectively favors *one* of the framed alternatives.

Table 5 Arguments for description invariance and for multiple perspectives used in McKenzie et al.'s (in preparation) Experiment 3 on risky choice framing

Description Invariance Argument
It is not reasonable to make different choices because, in a problem like this, all that matters is the objective information – the outcomes and probabilities. How the outcomes and probabilities are described is not relevant. Since the objective information is the same, people should make the same decisions in the two scenarios.
For instance, suppose you chose Program A ("200 inhabitants will be saved") in Scenario (1). If you based this decision on the objective information, you should also choose Program A in Scenario (2). This is because, even though Program A is described differently in Scenario 2 ("400 inhabitants will die"), it is objectively the same in both scenarios (since 600 are at risk, 200 saved = 400 die).
What matters for this decision are the objective consequences of the programs, not how they happen to be described. As a result, it is not reasonable to make different decisions when the problem is described differently.
Multiple Perspectives Argument
It can be reasonable to make different choices because, in a problem like this, there isn't one unique "right" answer. There is more than one reasonable way to think about the problem. Indeed, to fully understand a complex problem, people often need to look at it from multiple perspectives. Different perspectives may emphasize different goals or values.
For instance, in this problem, depending on which perspective one takes, one might adopt a goal of guaranteeing that at least some inhabitants will survive (leading one to choose Program A), or a goal of creating a chance that everyone will survive (leading one to choose Program B). Or one might adopt some other reasonable goal.
Different descriptions might highlight different perspectives on the problem, leading people to adopt different reasonable goals and make different choices. Because multiple perspectives and goals may be legitimate, it can be reasonable to make different choices when the problem is described differently.

In short, we found that for both attribute and risky choice framing tasks, participants, especially those who exhibited framing effects, often judged that it was reasonable, or in the their best interest, to treat frames differently. Furthermore, arguments for and against description invariance had little effect on their views (see Slovic and Tversky 1974 for similar conclusions about violations of EUT's independence axiom; and for an alternative approach to the question, with rather different results, see Nielsen and Rehbeck 2022). Beyond anecdotal reports (e.g., Kahneman and Tversky 1984), there is little evidence that participants consistently want their choices to satisfy description invariance.

2 When and why framing effects are not mistakes

The distinction between errors and mistakes is usually invoked when arguing that what might be an error is not a mistake. That is, it is typically accepted that the laboratory response in question violates a rational norm, but it is argued that such behavior is adaptive in our natural environment. However, in the case of framing effects, we have claimed that most effects do not clearly demonstrate errors. Description invariance presupposes both normative completeness and information equivalence, but the completeness assumption is broadly uncompelling, and attribute framing experiments commonly employ information non-equivalent frames. And if framing effects are not errors in the laboratory, there is no reason to think that they indicate mistakes in real-world choice situations. Human values, like human concepts more

broadly (Sher et al. 2025c), are inherently imprecise, and the normative rankings they imply are likely to often be incomplete. In that case, frame-dependence in real-world choice environments does not demonstrate the suboptimality of any choice (i.e., that presentation of some frame leads a person to choose b over a, when $a \succcurlyeq b$ in the normative ranking entailed by their value commitments). Moreover, in the case of attribute framing, we have argued that it can be a mistake to be insensitive to the frame, because of empirical regularities in how speakers select frames in real-world communication environments. But the analysis can be taken a step further: We argue that information leakage provides not only a compelling rational account of attribute framing effects, but also an illuminating descriptive account.

In the previous section, we argued that, in typical attribute framing tasks in the judgment and decision-making literature, frames are not information equivalent – i.e., that a speaker's choice of frame leaks relevant information. In this section, we focus on the extent to which listeners are sensitive to information leaked from the speaker's choice of frame, and whether this sensitivity can explain observed framing effects. In other words, whereas we focused on information leakage in the previous section, here we focus on *information absorption*.

McKenzie and Nelson (2003) were the first to show not only that a speaker's choice of frame leaks information, but also that listeners absorb this information. In one study, participants were told to imagine that a person was describing the amount of water in a glass after the amount had changed. Some participants read that the person described the glass as "half empty" and others read that the person described the glass as "half full", and they reported whether they thought that the glass had been previously full or previously empty. Because speakers tend to describe previously full glasses in terms of how empty they are rather than how full they are (i.e., information is leaked), the prediction was that listeners would be more likely to infer that a glass described as "half empty" is more likely to have previously been full rather than empty (i.e., the leaked information will be absorbed). The prediction was confirmed, as were similar predictions for scenarios in which the glass was described as either "3/4 full" vs. "1/4 empty", and as either "1/4 full" vs. "3/4 empty"; in all these scenarios, participants were more likely to infer that the glass was previously full when the glass was described in terms of how empty it was. Moreover, in a medical scenario, listeners were more likely to infer that an old treatment led to lower (rather than higher) survival rates when the new treatment was described as resulting in a 50% survival rate rather than a 50% mortality rate. Speakers select frames systematically and, importantly, listeners exploit these regularities in interpreting the frames they receive. Indeed, listeners appeared sensitive to the degree of informativeness of the selected frame. For example, because speakers tend to describe containers in terms of how full they are, describing a glass in terms of how empty it is sends a relatively strong signal about the glass's previous state. In line with this information asymmetry, listeners were more likely to infer that a glass was previously full when it was described as "half empty" than they were to infer that a glass was previously empty when it was described as "half full".

To ensure that the above results were not due to demand characteristics, Sher and McKenzie (2006) tested the information absorption hypothesis using real behavior when participants were unaware of the purpose of the experiment. Each participant

sat at a table with two clear plastic cups in front of them. One cup was full of water, and the other was empty. In one experiment, participants were asked to pour water from one cup into the other, and half of the participants were asked to place "a half-empty cup" on the edge of the table, while the other half were asked to place "a half-full cup" on the edge. After pouring, the participants would have two cups containing the same amount of water, but the prediction was that participants would perceive the previously full cup as half empty and the previously empty cup as half full. Participants were indeed more likely to place the previously full cup on the edge of the table when asked for a "half-empty" cup. Other pouring experiments showed that participants were also more likely to furnish the previously full cup when asked for a "1/4 empty" rather than a "3/4 full" cup, and when they were asked for a "3/4 empty" rather than "1/4 full" cup.

The research reviewed above shows that listeners draw different inferences from different frames – and these inferences are appropriate, given empirical regularities in speakers' frame selection. However, it does not demonstrate a causal connection between inferences and framing effects. Leong et al. (2017) addressed this issue in two experiments. Their first experiment provided evidence that inferences from frames are sufficient for producing framing effects. Participants were presented with a scenario involving a basketball player whose performance in the previous season was described as either "made 40% of shots" or "missed 60% of shots". One group of participants judged how valuable the player would be to a team, and they showed the usual framing effect, with those receiving the "made" frame reporting higher value ratings. A second group of participants was asked to estimate a typical player's percentage of shots made (or missed), and they tended to infer that typical players make fewer shots when the current player's performance was described in terms of shots "made" rather than "missed". A third group of participants was yoked with the second group, whose inferences about typical player performance were presented as background information along with the current player's unframed, or completely described, performance (i.e., "made 40% of his shots and missed 60% of his shots"), and reported how valuable the player is. Thus, this third group did not have the player's performance framed for them, but they did see their yoked participant's inference about typical player performance presented as background information. Note that half of the third group received an inference from a yoked counterpart who saw the "made" frame, and half from a yoked counterpart who saw the "missed" frame. This third group also showed a "framing effect", similar to the first group, even though the current player's performance was not framed for them. They rated the current player as more valuable when shown the inference from a yoked participant who was presented with the "made" frame (and who tended to infer that typical players' performance is lower than the current player) than when shown the inference from a yoked participant who was presented with the "missed" frame (and who tended to infer that typical players' performance is higher). For this third group, inferences from frames, and not the frames themselves, were sufficient to reproduce a valence-consistent shift.

Information leakage also predicts that framing effects should be attenuated when frame-based inferences are eliminated. Leong et al.'s (2017) second experiment showed that expertise in basketball was associated with a much reduced

"made"/"missed" framing effect. Those more knowledgeable about basketball are more likely to know what typical shooting performance is, and are therefore presumably less likely to draw frame-based inferences about typical performance. Those with less knowledge about typical player performance are more likely to rely on the valence of the frame to infer typical performance, and as a result they showed larger framing effects. To make sure that it was not the case that these basketball experts were less likely to show framing effects in general, Leong et al. presented these same participants with a second attribute framing scenario regarding a medical treatment outcome (shown in Table 2), and the resulting framing effect was equally strong for all levels of basketball expertise.

3 Conclusion

The principle of description invariance, we have argued, rests on two critical implicit assumptions. If rational preferences are complete and transitive, there will generally be a well-defined best option in a finite choice set; and if frames are uninformative, the best option will be frame-independent. A framing effect then implies the existence of a suboptimal choice. But when the completeness assumption fails (as it often does), framing effects are not counter-normative; and when the information equivalence assumption fails (as it does in attribute framing experiments), framing effects can be normatively mandated. Furthermore, contrary to anecdotal assumptions, participants in framing studies report mixed attitudes about the reasonableness of framing effects, and are not persuaded by normative arguments for description invariance.

While we have argued that typical framing effects are neither "errors" nor "mistakes," in Funder's (1987) classification, a caveat should be noted. Although typical framing effects do not imply that any choice is suboptimal, and hence do not demonstrate errors in between-subjects designs, similar patterns of inconsistent choice can sometimes be leveraged to generate subtle errors in *within-subjects* designs. That is, even if two inconsistent choices are unproblematic in isolation, they can sometimes be problematic in combination. For example, Kahneman and Tversky (1984) reported a study in which inconsistent risk attitudes for gains vs. losses across two successive problems led to a pair of choices that, in conjunction, violated the principle of dominance.[9]

Yet there are reasons to doubt whether such errors within the laboratory translate into mistakes beyond it (see also Arkes et al. 2016). First, it is unclear whether subtle experimental constructions like the one noted above (cf. footnote 9) have counterparts in real-world choice under uncertainty. Second, in more familiar and intuitive choice situations, DMs may strive to be "coherently arbitrary," carrying forward arbitrary preferences expressed in an initial choice problem to subsequent related prob-

[9] The dominance principle states that, if one gamble sometimes yields outcomes that are superior to another gamble, and otherwise yields identical outcomes, then the first gamble should be chosen. Unlike description invariance, the dominance principle does not assume completeness or information equivalence. In the study cited above, gain and loss values were precisely calibrated so that the choice of the sure thing in a gain problem followed by the choice of the gamble in a loss problem would jointly form a composite gamble marginally dominated by that which would result from the opposite pattern of choices.

lems (Ariely et al. 2003). Sher et al. (2025a) argue that coherent arbitrariness may perform the adaptive function of protecting DMs from costly kinds of within-subjects inconsistency, while allowing harmless varieties of between-subjects inconsistency. Finally, we have argued elsewhere (Müller-Trede et al. 2018) that the pattern of risk attitudes posited by prospect theory (risk aversion for gains and risk seeking for losses) may be an artifact of numerical cognition, in laboratory tasks where outcomes are explicitly quantified. If so, laboratory errors resulting from inconsistent risk attitudes may not translate into mistakes in typical real-world choice problems, where outcomes are often represented qualitatively rather than quantitatively (Sher et al. 2025b).

Importantly, the lessons we have drawn about description invariance – that (1) it assumes completeness and information equivalence; (2) these assumptions are often questionable; and (3) information non-equivalence explains some invariance violations – generalize to other influential coherence norms of rational choice. For example, the principle of *procedure invariance* states that different methods for eliciting preferences should yield the same ordering of options, while *independence of irrelevant alternatives (IIA)* states that the ranking of any two options should not be affected by the inclusion of additional options in a choice set. Many apparent violations of procedure invariance have been demonstrated, including default effects (Johnson and Goldstein 2003), joint-separate reversals (Hsee 1996), and choice-pricing preference reversals, in which participants select safer options in pairwise choice but assign higher prices to risky options (Lichtenstein and Slovic 1971). And although IIA entails that enlarging a choice menu to include a dominated "decoy" alternative (which would never be chosen) should never affect choices among the original options, this requirement is violated by the asymmetric dominance effect (Huber et al. 1982).

Like description invariance, the principles of procedure invariance and IIA presuppose both completeness and information equivalence, for analogous reasons: If rational preferences are complete and transitive, it can generally be assumed that there is a well-defined best option in each (procedure or menu) condition. Furthermore, if procedures or contextual decoy options are uninformative, this optimum would be the same in all conditions. Thus, if different procedures or decoys lead to different choices, it would follow that at least one choice must be suboptimal.

But if rational preferences are incomplete, then effects of elicitation procedures and irrelevant alternatives do not establish that any choice is suboptimal (for related arguments, see Eliaz and Ok 2006 and Butler and Loomes 2007). Moreover, choice-relevant information can be leaked, not only from the speaker's choice of frame, but also from the choice procedure and the composition of the choice menu. Inferences from procedures and menus may, in turn, explain some violations of procedure invariance and IIA (Kamenica 2008; Sher et al. 2022). For example, the default set by a choice architect may leak an implicit recommendation to the DM (McKenzie et al. 2006); different options sampled in joint vs. separate evaluation of alternatives may support different inferences about the market distribution of an unfamiliar attribute (Sher and McKenzie 2014); and similar inferences may be drawn from the presence of a dominated decoy option in a choice menu (Prelec et al. 1997). When procedural and contextual variables convey choice-relevant information, a theory

of rational choice does not only allow, but may sometimes require, procedure- and context-dependent decisions.

The three norms we have discussed – description invariance, procedure invariance, and IIA – all share a critical property. They are "coherence norms." They demand that the choices the DM would make in different situations be mutually consistent, but they say nothing about what the DM should choose in any given situation. Indeed, this substantive agnosticism is precisely what makes coherence norms so powerful in experimental studies of rationality (Sher et al. 2025a). The researcher is rarely in a position to know what choice is optimal for a given DM (i.e., which option best aligns with the DM's interests, whatever those interests may happen to be). But the researcher is well-positioned to assess the consistency of the DM's choices. And if the normative ranking of options (i.e., according to how well they align with the DM's interests) is *assumed* to be complete, an inconsistency generally entails that some choice must be suboptimal. The researcher thus appears to have pulled off the remarkable feat of demonstrating suboptimal behavior, without having any idea of which behaviors are or are not optimal. Yet we have argued that these feats are usually illusory, because the implicit assumption of completeness is rarely warranted.

This does not mean, of course, that people are perfectly rational. Nor, for that matter, does it mean that framing effects can never raise questions about rationality. They may do so, but indirectly – by providing evidence for psychological theories of decision making that, in turn, predict patterns of choice that frustrate the DM's best interests. Yet this assessment requires *substantive* knowledge about the structure and content of the DM's interests. When we have such substantive knowledge, we do not need coherence norms like description invariance to study rationality – we can ask whether choices are good or bad, not just whether they are consistent. When we lack such knowledge, coherence principles like description invariance will not answer our questions. Behavioral violations of the principle, within the laboratory and beyond it, may be neither errors nor mistakes.

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