scientific reports

OPEN

Incidental affect influences choice preference among competing alternatives in a modified Affect Misattribution Procedure

Ewa Kochanowska[1,2]✉, Elena Reutskaja[2] & Jolie Wormwood[1]

Affective feelings exert a powerful influence on decision making, even when the source of those feelings is incidental, i.e., unrelated to the decision at hand. Research on the role of affect in decision making has typically focused on how incidental affect shapes evaluations of an individual target, and thus decisions about how to engage with that target. It is less clear, however, if and how individuals use their incidental affective feelings when evaluating and comparing multiple competing targets and deciding which one to choose. To investigate this, we modified the Affect Misattribution Procedure (AMP) to include two competing targets, presented sequentially, that individuals needed to choose between. In two pre-registered studies ($N = 196$ and $N = 214$), participants were presented with pairs of landscape images (e.g., beaches, lakes) and asked to choose which image in the pair they liked more. Each landscape was preceded by an affective prime: a briefly flashed image of a face that was either smiling (a positive prime), scowling (a negative prime), or neutral (a neutral prime). We found that participants were significantly more likely to choose landscapes preceded by primes of more positive valence, and this effect was driven by trials on which the positive prime came second. Our studies demonstrate that decision makers use their incidental affective feelings when making choices among competing alternatives, and introduce a novel methodology for understanding the constructive role of affect in preference formation.

Keywords Affect, Priming, Choice, Preference construction, Affect Misattribution Procedure

Affective feelings exert a powerful influence on judgement and decision making, including decisions about how much food to eat[1], which risks to take[2–4], whom to trust[5,6], and how to invest[7]. In fact, evidence suggests that affect influences our perception and behavior even when it is incidental—i.e., unrelated to the task or judgment at hand[8,9]—and even when affect-eliciting sources are presented outside awareness[10–12]. While previous work has largely focused on decisions and judgments rather than choices per se, here we specifically examine how incidental affect influences which of two competing choice alternatives is selected.

Affect is an aspect of subjective experience that reflects how we feel at any particular point in time[13], and is typically described in terms of two dimensions: valence (ranging from feeling pleasant to unpleasant) and arousal (ranging from feeling activated to deactivated in the body[14–16]). Affective feelings differ from moods, which tend to be more diffuse, lower in intensity, and persist in the background over time, and from discrete emotions (e.g., anger, fear), which are more intense, arise rapidly, and are typically directed toward a specific object or situation[17].

The influence of affect on perception and behavior is often understood in terms of the affect-as-information theoretical framework[18,19]. This framework suggests that people use their feelings as a source of information about the world, including objects, experiences, decisions, and other people. Specifically, affect is thought to assign value to whatever *appears* to be causing it[20], even if the true source of affect is unknown or irrelevant. As such, people can misattribute the cause of their current affective state to things in the world. For example, individuals experiencing negative affect perceive tones as louder[21], and strangers seem more likeable for people who are in a positive mood[6,22]. Additionally, previous research on aesthetic preferences has shown that incidental affect can shape evaluations of visual stimuli such as art, with perceivers experiencing artwork more positively when feeling good[23,24].

[1]Department of Psychology, University of New Hampshire, 213 McConnell Hall, 15 Academic Way, Durham, NH 03824, USA. [2]Department of Marketing, IESE Business School, Barcelona, Spain. ✉email: ewa.julia.kochanowska@gmail.com

Beyond perception, research on the role of incidental affect in decisions has focused largely on how affect shapes evaluations of an individual target, and thus decisions about how to engage with that target based on its subjective value; for example, decisions about how much to consume[11], or decisions about whether or not to engage in prosocial behavior[25,26]. However, many decisions involve choice, which requires the evaluation and comparison of multiple competing targets simultaneously, or near simultaneously[27,28]. For example, selecting one of a number of job applicants to hire, deciding which candidate to vote for in an election, or choosing which dish to order from a list of options on a restaurant menu. Here, we use the term choice to refer to such decisions: deciding not whether or how much to engage with a particular object/person/task, but deciding *which* object/person/task is preferred among several competing alternatives.

Research on competitive choice scenarios often represents choosing as a process of accessing and combining attribute information about different alternatives, where the overall evaluation of each alternative is the product of some attribute-based computation[29,30]. Notably, prior research suggests that individuals adapt their evaluation strategies depending on the nature and complexity of the choice task, and may shift between different strategies based on context[31,32]. For example, contextual factors such as time pressure or the number of alternatives can influence whether individuals rely on quick heuristics (e.g., satisficing, where they settle for alternatives that meet a basic threshold[33]) or engage in more deliberate, multi-attribute decision-making[34]. While evaluations can be attribute-based, they may also be feeling-based: rather than computing evaluations purely from the target's attributes, people may rely on the feelings experienced as they consider the target[19,35,36]. Our studies advance this prior work by exploring how brief changes in incidental affect that covary with choice alternatives provide moment-to-moment evaluative cues that inform participants' choices.

Specifically, we examine whether and how people use their incidental affective feelings as a source of information in choices between competing alternatives. We build on affect-as-information theory[36] as a general theory of how incidental affect can influence evaluations of targets, and we extend this framework to the domain of preference construction and choice. Research on preference construction suggests that preferences may not be well-defined a priori but rather be constructed at the time a valuation question is asked, and thereby may be influenced by a number of contextual factors outside of the choice itself[37–39]. In the present studies, we integrate preference construction theories with affect-as-information theory to propose that incidental affect can serve as a contextual factor outside of the choice itself that influences the construction of preferences in the moment. That is, because people are attempting to form a preference when they consider targets of valuation during choice, concurrent incidental affect can be misattributed to a target under consideration, and thus shape the preference that is formed in that moment about the target.

In order to examine whether people use incidental affective information when evaluating alternatives to make a choice, we decided to adapt an existing method for assessing how incidental affect shapes evaluations of individual targets, the Affect Misattribution Procedure (AMP)[40]. In a typical AMP study, participants are asked to subjectively evaluate neutral target images (e.g., Chinese characters) which are preceded by briefly (but not subliminally) flashed affectively positive or negative primes (e.g., smiling or scowling faces) (for a review, see[41]). Despite being explicitly instructed to ignore the primes when evaluating the targets, participants are nonetheless influenced by the valence of the primes, such that neutral targets tend to be perceived more positively if preceded by positive primes and more negatively if preceded by negative primes[42,43]. This effect is thought to emerge due to the misattribution of the affective information elicited by the primes: the briefly flashed positive and negative images elicit momentary affective feelings whose source is misattributed to the neutral targets, thereby influencing target evaluations in a way that is consistent with the valence of the prime[40,44] (though see[45] for a discussion of potential alternative mechanisms).

Here, in two preregistered studies, we modified the standard AMP so that every trial included two targets, presented sequentially, that participants needed to choose between. Each of the two targets was preceded by a briefly flashed prime that varied in affective valence. In Study 1, on each trial individuals had to choose between two targets where one was preceded by a positive prime and one was preceded by a negative prime. In Study 2, on each trial individuals had to choose between two targets where one was preceded by a neutral prime and the other was preceded by either a positive or negative prime. By independently manipulating the valence of the primes presented alongside each of the two targets, we tested whether incidental affective information influenced which target participants were more likely to choose. Across both studies, we predicted that affective primes would influence choice such that targets preceded by primes of more positive valence would be chosen more often.

A unique feature of our studies is that the elicited affect was of very short duration, changing within and across trials lasting only a few seconds. This allowed us to explore how rapid changes in affect, rather than stable affective states, provide moment-to-moment evaluative cues that inform participants' choices. In doing so, we demonstrate how the theories of preference construction and affect-as-information intersect. Specifically, we show how brief affective feelings that covary temporally with choice alternatives are integrated in the moment to construct preferences and influence which alternative is chosen.

Study 1

In Study 1, we presented participants with choices between positively-primed targets and negatively-primed targets, to test whether they were more likely to choose targets preceded by positive primes. In addition, on some trials in Study 1 participants had to choose between two targets preceded by primes of the same valence: both positive or both negative. Prior work suggests that affect may guide decisions such that impairments in the processing of affective information are associated with decision-making deficits and difficulties in resolving choice[46–48]. Therefore, we predicted that incidental affective information of contrasting valence (positive versus negative) would make the choice easier than incidental affective information of the same valence (both positive or both negative). We compared response times for contrasting valence trials versus same valence trials to test this prediction.

Methods

All studies, measures, manipulations, and data/participant exclusions are reported in the manuscript or its Supplementary Material. This study's methods, analyses, and predictions were pre-registered on AsPredicted (#52096).

All experimental protocols were approved by the University of New Hampshire Institutional Review Board for the Protection of Human Subjects in Research (protocol number: IRB-FY2022-89). All methods were carried out in accordance with the Institutional Review Board guidelines and regulations.

Sample size and power

The number of trials per condition was selected based on the median number of trials in previous studies using the AMP as reported in[41]. The number of participants was selected based on a power analysis conducted in G*Power 3.1 for a repeated-measures ANOVA, which suggested that the minimum sample size to achieve a power of 0.80 with a two-tailed alpha of 0.05 for 5 within-subject conditions and a small effect size was $N = 121$. This was taken as a conservative sample size estimate as analyses were conducted using generalized linear mixed effects models, which afford greater power than repeated measures analyses. To account for data loss common in online data collection, we decided to recruit 200 participants to complete our study with the goal of retaining an analytic sample greater than $N = 121$.

Participants

Two hundred and twenty-nine participants ranging in age from 18–29 years ($M_{age} = 19.1$ years, $SD_{age} = 1.5$ years) completed the study for partial credit toward completion of their undergraduate psychology course. Participants were predominantly female (69.4% female, 29.3% male, 1.3% other) and white (86.9% white, 6.1% Asian, < 5% each of Black and other race not listed). Eligible participants had to be at least 18 years old and speak English fluently. Informed consent was obtained from all participants before the study began. Of the 229 participants, 33 were excluded from analyses because they either did not complete both parts of the study ($n = 15$), or did not meet our preregistered exclusion criteria: incorrectly answered at least two of three attention check questions ($n = 18$), or completed the Landscape Image Task with a straight-liner pattern of response (i.e., only one response option used throughout entire task, $n = 4$). Thus, the final analytic sample size was $N = 196$, ranging in age from 18–29 years ($M_{age} = 19.04$ years, $SD_{age} = 1.5$ years; 72.4% female, 26.6% male, < 5% other; 87.7% white, 5.1% Asian, 5.1% other race not listed, < 5% Black).

Stimuli

Faces We used images of faces as our prime stimuli. All face images were pulled from the Interdisciplinary Affective Science Laboratory Face Set, a normed facial stimulus set which was developed with support from the National Institutes of Health Director's Pioneer Award (DP1OD003312) to Lisa Feldman Barrett. Informed consent to publish has been obtained from the models for this study. Emotion expressions in this stimulus set were posed. Models were given instructions concerning the facial muscles to move for each expression. For example, for neutral expressions, models were told "Let your face hang in a relaxed, natural position. Look straight into the camera." For the current studies, we selected 24 unique identities (12 female and 12 male) at random from this larger facial stimulus set. Each of the 24 identities was available with both a smiling expression and a scowling expression.

Landscapes We used images of landscapes as target stimuli. All landscape images were taken by photographer QT Luong and are available on his website. He has given permission for his photographs to be used in the current studies. Only images of natural landscapes (e.g., beaches, forests, mountains) without people or buildings have been selected for use in the studies.

Pilot studies to develop the choice stimuli In order to test whether the valence of primed images would influence which one of the two target landscapes was chosen on each trial, it was important to ensure that we presented participants with choice alternatives that tend to elicit similar preferences. Thus, we ran two pilot studies (see supplemental materials for results of both pilot studies). In the first pilot, we presented 370 landscape images from five different landscape categories (beaches, forests, lakes, mountains, and waterfalls) to 348 participants recruited via Amazon Mechanical Turk. Participants rated how much they liked each image using an 11-point Likert-like scale ranging from 0 (*Don't like it at all*) to 10 (*Like it a lot*). Based on this data, we calculated mean liking ratings for each image, as well as correlations of ratings for all possible pairs of images within the same landscape category. We then selected pairs of landscape images from each category by putting together the landscapes with the most similar mean liking ratings and the highest rating correlations, resulting in 180 unique pairs of landscapes (36 pairs from each of the five landscape categories).

In the second pilot, we presented the 180 landscape pairs to 208 University of New Hampshire undergraduates recruited via the university's research participation system in return for partial course credit. Participants viewed each landscape in the pair for 200 ms and were asked to report which of the paired images they preferred. Ratings were made on a 6-point scale ranging from − 3 (*Strongly prefer landscape A*) to 3 (*Strongly prefer landscape B*) with no 0/no preference option. We then calculated mean preference ratings for each landscape pair to ensure that mean ratings were close to the midpoint of the scale—meaning that, on average, participants did not have a strong preference towards either of the two landscapes in the pair. Results are reported in more detail in the supplemental materials. The final set of paired images for the Landscape Image Task consisted of 120 landscape pairs selected from the larger set of 180 pairs that were normed in the second pilot.

Procedure

Participants completed the study online in a single session lasting approximately 30 min. Following informed consent, participants completed the Landscape Image Task (described below). After the Landscape Image Task, participants completed an approximately 15-min online survey via Qualtrics (Provo, UT), in which demographic and individual difference measures were collected.

Tasks and measures

Landscape image task The Landscape Image Task was programmed in Inquisit 6 (http://www.millisecond.com) and was presented using the Inquisit Web Player (Version 6.4.1). Participants downloaded the Inquisit Web Player application on their personal computers to complete the task online. To program the task, we adapted the Affect Misattribution Procedure (AMP)[40] to include two primes (i.e., faces) and two targets (i.e., landscapes) in each trial.

Participants were told that we were interested in their gut-feeling preferences regarding the target landscape images, and were instructed to respond based on their initial reactions. They were further instructed that a briefly flashed image of a face would precede each landscape, but that the face image simply serves as a signal that the landscape will appear and should otherwise be ignored. Further, participants were told that the face images could sometimes bias people's judgments of the landscapes, and that—since we were interested in how people can avoid being biased—they should try their absolute best not to let the face images bias their judgment of the landscapes. The phrasing of these instructions is consistent with previous studies using the AMP[41].

Each trial of the landscape image task began with a 500 ms fixation cross and ended by asking for a preference rating. In each trial, participants viewed two landscape images from a single landscape category (beaches, forests, lakes, mountains, or waterfalls) one at a time, each presented for 300 ms followed by a 100 ms backward mask. Each landscape image was preceded with a 75 ms affective prime: a briefly flashed image of a face that was either smiling (a positive prime) or scowling (a negative prime). Prime and target durations followed the recommendations in[41] for Affective Misattribution Paradigms. At the end of the trial, participants were asked to respond by pressing one of two buttons on a standard keyboard to indicate which of the two landscape images they preferred, the first or the second image seen. See Fig. 1 for the complete trial structure.

Participants first completed 4 practice trials, in which we only used faces with a neutral expression as primes. Participants then completed a total of 120 trials of the Landscape Image Task comprising 4 within-subject conditions of 30 trials each: Positive–Negative trials (Pos-Neg; first landscape preceded with a smiling face and second landscape preceded with a scowling face), Negative–Positive trials (Neg-Pos; first landscape preceded with a scowling face and second landscape preceded with a smiling face), Positive-Positive trials (Pos-Pos; both landscapes preceded with a smiling face), and Negative-Negative trials (Neg-Neg; both landscapes preceded with a scowling face). The order in which trials were presented was randomized.

To control for potential order effects, each landscape image appeared in two choices, once first and once second in the pair, but each time paired with a different other landscape image, resulting in 120 unique pairs. Within subjects, each landscape image was always preceded with a face prime of the same valence for both presentations: either positive (smiling) or negative (scowling). Further, landscape order within a given pairing and prime valence assigned to a given landscape image were counterbalanced between-subjects. However, landscape and face identity matchings remained the same within- and between-subject. That is, a given landscape was always preceded by the same facial identity, but the facial expression was smiling for some subjects and scowling for others.

Individual difference measures Participants completed measures of multiple individual difference variables related to bodily awareness, emotion reactivity, social desirability, and demographic information. As these are not the primary focus of this investigation, these measures are described in full in the supplemental materials.

Analytic approach

Before conducting analyses, we followed the data exclusion steps outlined in the study's preregistration. First, we excluded all data for any participants who incorrectly answered at least two of our three attention check questions ($n = 18$) or completed the Landscape Image Task with a straight-liner pattern of response ($n = 4$). Then, we log-transformed the response time variable to account for skew in the distribution, and we excluded any outlier trials with response time values more than 3 SD above the sample mean ($M_{log} = 6.08$; $SD_{log} = 0.92$; 101 individual trials excluded; $< 1\%$ of total).

To assess the likelihood of choosing the landscape image preceded by a positive prime in each trial for the Pos-Neg and Neg-Pos conditions, we created a dummy-coded outcome variable with the value of 1 if the landscape with a positive prime was chosen and 0 otherwise. We adopted a mixed effects binary logistic regression approach, with trials nested within participants; all models assumed random intercepts for each participant to account for individual differences in the overall response pattern. All mixed effects models in Study 1 are predicting the binary outcome (selected landscape paired with a positive prime or not) from a null (intercept only) model. The fixed effect for the intercept provides the average log-odds of selecting the landscape paired with a positive prime (v. the landscape paired with a negative prime), with the significance test indicating whether the log odds differ from 0 (i.e., whether the odds of selecting the landscape paired with a positive prime differ from 1). The random effect estimate for the intercept describes the amount of variability in this effect across individuals. Models were fit using the maximum likelihood (Laplace Approximation) method of estimation for model parameters. Regression analyses were conducted in *R* using the 'lme4' package[49].

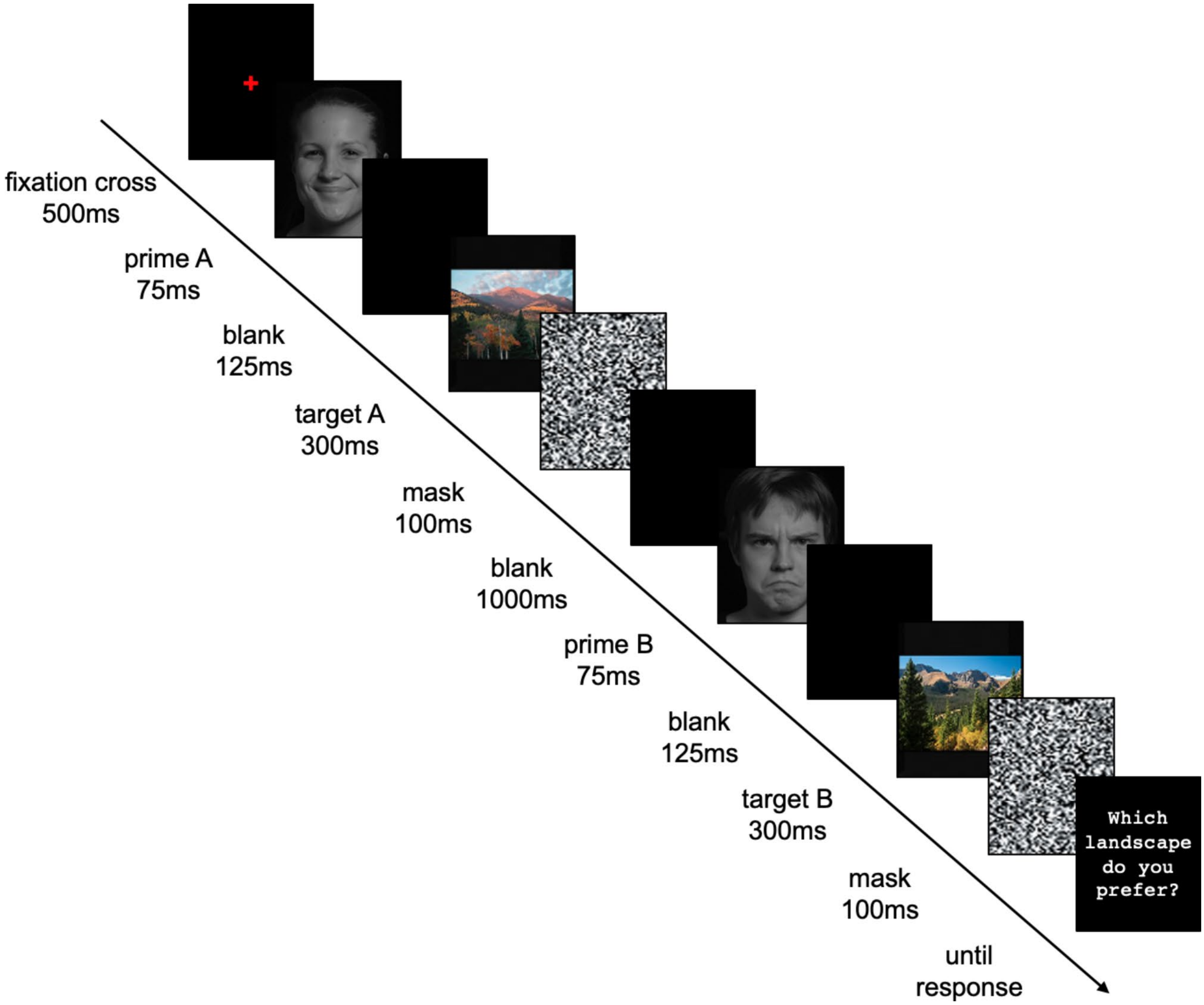

Fig. 1. Trial structure for the Landscape Image Task. The example trial here illustrates the Positive–Negative condition (i.e., first landscape preceded with a smiling face and second landscape preceded with a scowling face).

To assess whether participants took less time to make a choice on trials where landscapes were preceded with primes of contrasting valence (Pos-Neg and Neg-Pos conditions) compared to trials where both landscapes were preceded with primes of the same valence (Pos-Pos and Neg-Neg conditions), we ran a repeated-measures ANOVA on the log-transformed response time variable. ANOVA analyses were conducted in *R* using the 'ez' package[50].

Results

Effect of prime valence on choice

To assess whether participants were more likely to choose landscape images preceded by positive primes (smiling faces) than by negative primes (scowling faces), we used an intercept-only model with participant as a random factor for trials in the Pos-Neg and Neg-Pos conditions only (i.e., models contain estimated fixed and random effect values for the intercept only). As predicted, the odds of choosing the landscape preceded with the positive prime were significantly greater than one ($B = 0.11$, $SE = 0.03$, $Z = 4.14$, $p < 0.001$; odds ratio = 1.11). Participants chose the landscape image paired with the positive prime 52.7% of the time.

We also assessed the likelihood of choosing the positive-primed landscape for the Pos-Neg and Neg-Pos conditions separately. Participants were significantly more likely to choose the positive-primed landscape in the Neg-Pos condition ($B = 0.20$, $SE = 0.04$, $Z = 4.64$, $p < 0.001$; odds ratio = 1.22), selecting it 55.0% of the time, but not in the Pos-Neg condition ($B = 0.03$, $SE = 0.05$, $Z = 0.57$, $p = 0.571$; odds ratio = 1.03), selecting it only 50.6% of the time. See Table 1 for a summary of results.

Fixed effects	B (Log Odds)	SE	Z	p	OR	Probability
Model A: Overall	0.108	0.026	4.141	< 0.001	1.114	52.703%
Model B: Pos-Neg condition	0.025	0.045	0.566	0.571	1.026	50.631%
Model C: Neg-Pos condition	0.200	0.043	4.642	< 0.001	1.222	54.994%
Random effects	**Estimate**	***SD***				
Model A: Overall	0.066	0.256				
Model B: Pos-Neg condition	0.248	0.498				
Model C: Neg-Pos condition	0.223	0.472				

Table 1. Output from mixed effects models predicting the odds of choosing the landscape preceded with the positive prime.

Fixed effects	B (Log Odds)	SE	Z	p	OR	Probability
Model A: Overall	0.097	0.031	3.171	< 0.010	1.102	52.416%
Model B: Pos-Neg condition	− 0.025	0.045	− 0.566	0.571	0.975	49.369%
Model C: Neg-Pos condition	0.200	0.043	4.642	< 0.001	1.222	54.994%
Model D: Pos-Pos condition	0.176	0.038	4.675	< 0.001	1.192	54.378%
Model E: Neg-Neg condition	0.039	0.039	1.009	0.313	1.040	50.975%
Random effects	**Estimate**	***SD***				
Model A: Overall	0.148	0.384				
Model B: Pos-Neg condition	0.248	0.498				
Model C: Neg-Pos condition	0.223	0.472				
Model D: Pos-Pos condition	0.137	0.370				
Model E: Neg-Neg condition	0.154	0.392				

Table 2. Output from mixed effects models predicting the odds of choosing the second landscape in the pair.

Effect of prime valence on response time

Contrary to predictions, a repeated-measures ANOVA revealed that participants did not take less time to make a choice on trials where landscapes were preceded with primes of contrasting valence (Pos-Neg and Neg-Pos conditions) compared to trials where both landscapes were preceded with primes of the same valence (Pos-Pos and Neg-Neg conditions), $F(1,195) = 0.000$, $p = 0.990$, $\eta^2 < 0.001$.

Exploratory analysis of order effects

Given that the effect of prime valence on choice was significant on trials where the first prime was negative and the second prime was positive (Neg-Pos condition) but not on trials where the first prime was positive and the second prime was negative (Pos-Neg condition), we ran exploratory analyses to further investigate order effects. We created a dummy-coded outcome variable with the value of 0 if the first landscape in the pair was chosen on a given trial, and the value of 1 if the second landscape was chosen. We then ran a series of intercept-only models with participant as a random factor to estimate the likelihood of choosing the second landscape. We found that, overall, individuals were more likely to choose the second landscape in the pair ($B = 0.10$, $SE = 0.03$, $Z = 3.17$, $p < 0.010$; odds ratio = 1.10). When testing each condition separately, this was also true on trials where the second landscape was primed with a positive image (Neg-Pos and Pos-Pos conditions) but not on trials where the second landscape was primed with a negative image (Pos-Neg and Neg-Neg conditions). See Table 2 for a summary of results.

Individual difference measures

Exploratory analyses revealed that the main effect of priming on choice was not moderated by any of the individual difference measures (body awareness, interoceptive challenges, emotion reactivity, or social desirability); see supplemental materials.

Discussion

In Study 1, individuals were more likely to choose landscapes when they were presented paired with incidental affective information of positive valence. These results provide evidence that incidental affect plays a role in preference construction when evaluating competing alternatives to make a choice. When evaluating conditions separately, we found that the effect of affective priming on choice was largely driven by the Neg-Pos trials, and not significant for the Pos-Neg trials. We also discovered an overall preference towards the second landscape in each pair, suggesting that the order of choice alternatives affects choice outcomes in the paradigm we used. Affective priming appears to be working *with* this tendency when the second landscape is positively primed (Neg-Pos and Pos-Pos conditions), and *against* it when the second landscape is negatively primed (Pos-Neg and Neg-Neg conditions), resulting in a null effect in the latter case.

Because choices in Study 1 all involved competing alternatives that were primed with positive or negative affective information, it is unclear if the preference for positively-primed landscapes over negatively-primed landscapes was driven by some positive effect of the smiling face primes, some negative effect of the scowling face primes, or a combination of the two. Moreover, given that participants tended to prefer the second landscape in each choice on average, it is unclear whether a comparison against even odds (i.e., 50/50%) was the most appropriate comparison point when assessing the effect of affective priming on choice. In Study 2, we set out to replicate the main finding of Study 1, as well as address those two open questions.

Study 2

In Study 2, we explored if the effect of incidental affective information on choice depends on whether affective primes are positive or negative in valence. We presented participants with the same set of choices between two landscapes, but only one of the landscapes was preceded with an affective prime (either a smiling or a scowling face) while the other landscape in the pair was preceded with a neutral prime (a face with a neutral expression). As such, we could compare the effects of priming for trials involving choices between landscape images presented with positive versus neutral primes and for trials involving choices between landscape images presented with negative versus neutral primes.

In addition, to better control for potential order-based preferences, in Study 2 we also collected choice ratings for all 120 landscape pairs presented only with neutral primes (i.e., using faces with neutral expressions for both primes in each trial). In so doing, we could compare the odds of selecting the landscape image paired with the more positive (less negative) prime against the odds of selecting that same image from among the same pairing in the absence of an affective prime. Because the presentation order of the landscape images is the same across these two conditions, this comparison controls for any potential influence of order on choice and offers an alternative comparison point above and beyond even odds (i.e., 50/50%).

Methods

This study's methods, analyses, and predictions were pre-registered on AsPredicted (#63513).

All experimental protocols were approved by the University of New Hampshire Institutional Review Board for the Protection of Human Subjects in Research (protocol number: IRB-FY2022-89). All methods were carried out in accordance with the Institutional Review Board guidelines and regulations.

Sample size and power

The number of trials per condition was selected based on the median number of trials in previous studies using the AMP as reported in[41]. The number of participants was selected based on a power analysis conducted in G*Power 3.1 for a repeated-measures ANOVA, which suggested that the minimum sample size to achieve a power of 0.80 with a two-tailed alpha of 0.05 for 5 within-subject conditions and a small effect size was $N=121$. Analyses were conducted using generalized linear mixed effects models, which afford greater power than repeated measures analyses. To account for data loss common in online data collection, we decided to recruit 200 participants to complete our study with the goal of retaining an analytic sample greater than $N=121$.

Participants

Two hundred and thirty participants ranging in age from 18–47 years ($M_{age}=19.4$ years, $SD_{age}=2.2$ years) completed the study for partial credit toward completion of their undergraduate psychology course. Participants were predominantly female (71.3% female, 27.8% male, < 5% other) and white (88.3% white, 7.0% other race not listed, < 5% Asian or Black). Eligible participants had to be at least 18 years old and speak English fluently. Informed consent was obtained from all participants before the study began. Of the 230 participants, 16 were excluded from analyses because they did not complete both parts of the study ($n=5$), or did not meet our preregistered exclusion criteria: incorrectly answered at least two of our three attention check questions ($n=9$) or completed the Landscape Image Task with a straight-liner pattern of response ($n=2$). Thus, the final sample size was $N=214$ ranging in age from 18–47 years ($M_{age}=19.4$ years, $SD_{age}=2.2$ years; 70.6% female, 28.5% male, < 5% other; 88.3% white, 7.5% other race not listed, < 5% Asian or Black).

Stimuli

In Study 2, we used the same 120 landscape pairs and the same 24 face identities as in Study 1, with the exception that we also used faces with neutral facial expressions in some trials (see Landscape Image Task description below).

Procedure

Procedure for Study 2 was identical to that of Study 1, with the exception that only a subset of the individual difference measures was collected in Study 2.

Tasks and measures

Landscape image task The instructions and trial structure were nearly identical to that of Study 1. However, in Study 2 participants completed a total of 240 trials of the Landscape Image Task, and could take a short break every 60 trials. There were 5 within-subject conditions: 30 Positive-Neutral trials (Pos-Neu; first landscape preceded with a smiling face and second landscape preceded with a neutral face), 30 Neutral-Positive trials (Neu-Pos; first landscape preceded with a neutral face and second landscape preceded with a smiling face), 30 Negative-Neutral trials (Neg-Neu; first landscape preceded with a scowling face and second landscape preceded with a neutral face), 30 Neutral-Negative trials (Neu-Neg; first landscape preceded with a neutral face and second landscape preceded with a scowling face), and 120 Neutral–Neutral trials (Neu-Neu; both landscapes preceded with a neutral face). For the Neutral–Neutral trials, we presented the same 120 landscape pairs from the first four conditions, with the exception that all primes were faces with neutral expressions. The order in which trials were presented was randomized.

As in Study 1, to control for potential order effects, each landscape image appeared in two unique choices, once first and once second in the pair, but each time paired with a different other landscape image. Each of the 120 unique landscape pairs appeared twice: once in a primed trial (positive versus neutral prime, or negative versus neutral prime) and once in a neutral-only trial. Landscape order within a given pairing and prime valence assigned to a given landscape image were counterbalanced between-subjects. That is, if a given landscape was preceded with a smiling face for half of the participants, it was preceded with a scowling face for the other half, and vice versa. However, landscape and face identity matchings remained the same within- and between-subject. That is, a given landscape was always preceded by the same facial identity, but the facial expression was smiling, scowling, or neutral depending on condition.

Individual difference measures In the online survey following the Landscape Image Task, participants completed the Body Awareness Questionnaire[51] and the Interoception Sensory Questionnaire[52], in addition to demographic information. These measures are described in full in the supplemental materials.

Analytic approach

Before conducting analyses, we followed the data exclusion steps outlined in the study's preregistration. First, we excluded all data for any participants who incorrectly answered at least two of our three attention check questions ($n = 9$) or completed the Landscape Image Task with a straight-liner pattern of response ($n = 2$). Then, we log-transformed the response time variable to account for skew in the distribution, and we excluded any outlier trials with response time values more than 3 SD above the sample mean ($M_{log} = 6.02$; $SD_{log} = 0.96$; 214 individual trials excluded; < 1% of total).

To assess the likelihood of choosing the landscape image preceded with the more positive prime in each trial for choices involving positive v. neutral primes and negative v. neutral primes, we created a dummy-coded outcome variable to indicate whether the landscape with the more positive (less negative) prime was chosen on each trial. This variable took the value of 1 if the landscape with a positive (v. neutral) prime was chosen in the Pos-Neu and Neu-Pos conditions or if the landscape with a neutral (v. negative) prime was chosen in the Neg-Neu and Neu-Neg conditions, and it was 0 otherwise.

In addition, we ran separate analyses by comparing choice outcomes for landscape pairs where one of the primes was positive or negative versus choice outcomes for the same landscape pairs but with all-neutral primes. For the purpose of those analyses, we assigned values to the dummy-coded outcome variable for the 120 Neutral–Neutral trials. This variable took the value of 1 if the landscape image that was chosen in the Neu-Neu trial was the same image that was paired with the more positive (less negative) prime in the corresponding affective prime trial, and it was 0 otherwise. This allowed us to compare whether the odds of choosing a landscape preceded with a more positive prime are higher than the odds of choosing the same landscape from a given pair on a trial where all primes were neutral.

As in Study 1, we adopted a mixed-effects binary logistic regression approach, with trials nested within participants; all models assumed random intercepts for each participant to account for individual differences in overall response patterns. Models were fit using the maximum likelihood (Laplace Approximation) method of estimation for model parameters. Regression analyses were conducted in *R* using the 'lme4' package[49].

Results

Effect of affective priming on choice

Against even odds To assess whether participants were more likely to choose landscape images preceded with more positive primes (smiling versus neutral faces in some conditions, and neutral versus scowling faces in others), we used an intercept-only model with participant as a random factor. Thus, the fixed effect for the intercept provides information about the average log odds of choosing the landscape paired with the more positive (less negative) prime, and its significance test assesses whether these log odds differ from 0 (i.e., whether the odds of choosing the landscape paired with the more positive prime differs from 1). The random effect estimate provides information about how this effect differs across individuals. As predicted, the odds of choosing the landscape preceded with the more positive prime were significantly greater than one, $B = 0.07$, $SE = 0.02$, $Z = 3.95$, $p < .001$, odds ratio = 1.08; participants chose the landscape paired with the more positive prime 51.82% of the time.

We also assessed the likelihood of choosing the more positively-primed landscape for choices involving positive v. neutral primes (Pos-Neu and Neu-Pos) and for choices involving negative v. neutral primes (Neg-Neu and Neu-Neg) separately. Participants were significantly more likely to choose the more positive-primed landscape in the positive v. neutral conditions ($B = 0.17$, $SE = 0.03$, $Z = 6.72$, $p < 0.001$, odds ratio = 1.18), selecting the positive-primed landscape 54.16% of the time. However, participants were not significantly more likely to choose the more positively-primed landscape in the negative v. neutral conditions ($B = -0.02$, $SE = 0.02$, $Z = -0.84$, $p = 0.400$, odds ratio = 0.98), selecting the neutral-primed landscape 49.49% of the time. See Table 3 for a summary of results.

Against neutral–neutral choice Further, we compared the odds of choosing landscapes preceded with more positive (less negative) primes on the affectively-primed trials against the odds of choosing the same landscapes on all-neutral trials using a mixed effects binary logistic regression predicting choice from a condition variable indicating whether each trial was an affectively-primed or all-neutral trial. The fixed effect for the intercept is the estimate of the average log-odds of selecting the landscape paired with the more positive (less negative) prime in the all-neutral trials, with the random effect providing information about how much this varies across individu-

Fixed effects	*B (Log Odds)*	*SE*	*Z*	*p*	OR	Probability
Model A: Overall	0.073	0.018	3.950	< 0.001	1.075	51.818%
Model B: Pos v. Neu trials	0.167	0.025	6.721	< 0.001	1.182	54.160%
Model C: Neg v. Neu trials	− 0.020	0.024	− 0.841	0.400	0.980	49.494%
Random effects	**Estimate**	***SD***				
Model A: Overall	0.039	0.197				
Model B: Pos v. Neu trials	0.063	0.252				
Model C: Neg v. Neu trials	0.056	0.237				

Table 3. Output from mixed effects models predicting the odds of choosing the landscape preceded by the more positive (less negative) prime, overall and by valence of affective prime.

Fixed effects	*B (Log Odds)*	*SE*	*Z*	*p*	OR
Model A: all neutral v. primed positive					
Intercept (all neutral)	0.098	0.021	4.721	< 0.001	1.103
Primed v. neutral landscape pairs	0.067	0.025	2.659	0.008	1.069
Model B: all neutral v. primed negative					
Intercept (all neutral)	− 0.020	0.020	− 0.999	0.318	0.980
Primed v. neutral landscape pairs	− 0.00003	0.025	− 0.001	0.999	1.000
Random effects	**Estimate**	***SD***			
Model A: all neutral v. primed positive	0.025	0.157			
Model B: all neutral v. primed negative	0.021	0.144			

Table 4. Output from mixed effects models predicting the likelihood of choosing the landscapes preceded with more positive primes on primed trials versus the same landscapes on all-neutral trials, for positive > neutral choices (Model A) and neutral > negative choices (Model B). Intercept odds ratio reflects odds of selecting landscape in all-neutral trials. Condition variable odds ratio reflects comparison of odds in the primed v. all-neutral trails.

als, and the fixed effect for condition is the estimate of how the log odds of selecting the same landscape differ in the affectively-primed trials (v. the all-neutral trials). For a given landscape pair, participants were significantly more likely to choose a specific landscape on trials where it was preceded by a positive prime (selecting it 54.09% of the time) than on trials where it was preceded by a neutral prime (selecting it 52.44% of the time). However, participants were not significantly less likely to choose a specific landscape on trials where it was preceded by a negative prime (selecting it 49.50% of the time) than on trials where it was preceded by a neutral prime (also selecting it 49.50% of the time). See Table 4 for a summary of results.

Exploratory analyses

Exploratory analyses comparing response times across conditions and investigating individual difference variables as potential moderators are reported in the supplemental materials. In general, we found no differences in reaction times across conditions, and only self-reported body awareness appeared related to the strength of the affective priming effect, see supplemental materials.

Discussion

In Study 2, we replicated the main finding from Study 1, providing further evidence that incidental affect plays a role in preference construction when evaluating competing alternatives to make a choice. Overall, individuals were more likely to choose landscapes when they were presented with incidental affective information of more positive valence. When evaluating conditions separately, we found that the effect of affective priming on choice was largely driven by choices involving positive v. neutral primes, and was not significant for choices involving negative v. neutral primes. Thus, affective priming influenced choice when primes were positive but not when primes were negative. We found a similar pattern of results when comparing the odds of choosing landscapes preceded by more positive (less negative) primes against even odds as when comparing against the odds of choosing the same landscape from among the same pair in the absence of affective primes (to control for potential order-based preferences). Taken together, these results suggest that incidental affective information can influence choice, even when presented very briefly (75 ms) and when participants are explicitly instructed to disregard it. However, the effect appears limited to incidental positive affective information, as individuals were not less likely to choose an option when it was paired with negative incidental information (v. neutral information).

General discussion

In the present set of studies, we used a modified version of the Affect Misattribution Procedure (AMP)[40] to examine the effect of incidental affective feelings on choice. In line with predictions, results revealed that affective information presented alongside choice alternatives influenced which alternative was chosen. Specifically, in both studies we found that the valence of the affective primes was misattributed to choice alternatives, such that alternatives were more likely to be chosen if preceded by primes of more positive valence.

Our results are consistent with the affect-as-information theoretical framework[18,19], but extend previous findings in several ways. First, we demonstrate that affect misattribution extends beyond the perception of single targets: individuals also use their incidental affective feelings as a source of information when making choices among competing alternatives. Second, by showing that momentary changes in affect can influence choice outcomes, we bridge the affect-as-information literature with the domain of preference construction[37–39]. The theory of preference construction posits that a person's preferences for choice alternatives are not set in stone, but rather they are actively constructed in the process of choosing. Because the formation of preference is an emergent and malleable process, it can be influenced by various contextual factors, such as the way in which information about choice alternatives is framed[53,54], whether any alternative is set as the default choice[55], or whether choice alternatives are evaluated jointly or separately[56]. These findings demonstrate how different methods of choice presentation that are normatively equivalent (i.e., have the same choice alternatives) can reverse people's preferences and give rise to systematically different responses. In the present research, we propose that incidental affect experienced during the evaluation of choice alternatives can also influence people's preference construction and ultimately determine which alternative is chosen. This was particularly evident in Study 2, where we presented individuals with the exact same set of landscape choices (i.e., choices that were normatively equivalent) and observed that they made systematically different choices in the presence (v. absence) of incidental affective information, at least for choices involving positive affective primes.

A third contribution of this research is the novel adaptation of the AMP paradigm to investigate the role of affect in choice. Traditional AMP studies involve single target evaluations, and were originally employed to measure implicit attitudes to the prime stimuli—for example, as an alternative to the Implicit Association Test (IAT)[57]. In our set of studies, we modified the AMP such that each trial involved a choice between two targets. Hence, we created a paradigm in which one can independently manipulate the incidental affective information presented alongside each choice alternative to see whether it can influence which alternative is chosen. In addition, we developed a target library of normed choices (a set of 120 landscape image pairs matched for preference) that can be used together with our modified AMP task. With this methodological contribution, we hope to encourage the use of our new paradigm in future studies on the role of affect in preference formation and choice.

In Study 2, we explored if the influence of affect on choice depended on whether affective primes were positive or negative in valence. Interestingly, and somewhat unexpectedly, we found that incidental affective information influenced outcomes only for choices that involved a positive prime versus a neutral prime, and not for choices involving a negative prime versus a neutral prime. In other words, we found that positive affect *encouraged* the choice of a given option, but negative affect did not appear to *deter* from choosing a given option.

This result is different from what is typically found in traditional AMP studies involving evaluations of single targets—where both positive and negative primes tend to influence target evaluations. However, in a typical AMP study, the target images that participants need to evaluate are abstract or ambiguous, such as Chinese characters presented to non-Chinese speaking participants[43,58], inkblots[59], or abstract images[42,60,61]. In our set of studies, we decided to use images of natural landscapes in order to make the choice task more engaging. While the choice pairs in our studies were constructed in a way to make deciding between the two landscapes ambivalent (by pairing together landscapes that tend to elicit similar preferences), the landscapes themselves were likely more visually stimulating and more pleasant to look at than the more evaluatively neutral target stimuli that are typically used in AMP studies. As such, if participants' evaluations of the target landscapes were already positive, it is possible that these generally positive evaluations mitigated the impact of incidental negative affective information on choice. Given that real-life choices rarely involve completely neutral choice options, future work should further investigate the potential ways in which incidental affect may interact with preexisting positive or negative evaluations of choice alternatives to drive decision making.

Our findings can also be understood in light of the influence of affect on processing strategies. Previous research suggests that positive affect tends to promote more intuitive processing, while negative affect can trigger more analytic, detail-oriented processing[62–64]. Our pattern of results is consistent with these findings. In the Negative–Positive condition in Study 1, participants make their choice having just experienced positive affect (the last affective state induced before the decision), possibly encouraging reliance on intuitive feelings when selecting the positively primed alternative. In contrast, in the Positive–Negative condition, the lingering negative affect may prompt participants to engage in more analytic processing, leading them to rely less on affect and more on objective attributes of the alternatives and any pre-existing preferences for such attributes. This interpretation is further supported by the results of Study 2, where participants relied on their feelings when primes were positive but not when primes were negative.

Limitations

As with all experimental research, our studies are not without limitations. First, we observed evidence of order effects occurring in our choice paradigm: individuals had a tendency to prefer the second target landscape in a given choice pair. This kind of recency effect, whereby individuals tend to prefer later options when alternatives are presented sequentially, is well-documented in the literature on choice[65–67]. Recency effects are thought to occur because the latest items remain fresh in people's memories and are thus given more weight in choice. Given that the choice alternatives in our experimental paradigm were presented for relatively short periods of time (i.e., for 300 ms each), it is reasonable to expect that recently presented images would be more accessible in memory and thus more likely to be preferred. Furthermore, the sequential presentation of targets prevented participants from comparing alternatives side-by-side, potentially impairing attribute-based choice and increasing reliance on feelings. Future research looking to employ our paradigm would need to control for recency effects, as we did in Study 2, or consider methods that do not require a sequential presentation of choice alternatives.

A second potential limitation of the current studies is that the affective primes were supraliminal, i.e., presented above the threshold of perception. While the basic premise of a traditional AMP paradigm, as well as our modified version, is that the very brief presentation of primes triggers affective reactions that are automatic and not deliberate, it remains unclear whether incidental affect would influence choice in similar ways if its source was presented subliminally, outside of reportable subjective awareness. We encourage future work to explore this interesting possibility, for example by employing methods that allow for the presentation of primes outside of reportable awareness, such as continuous flash suppression (CFS)[68]. Such prime presentation could further mitigate the potential influence of demand characteristics on the study's outcomes. Even when instructed to disregard the faces in an AMP paradigm, participants likely register whether a face is smiling or scowling, potentially revealing the study's underlying hypothesis. While our Study 1 did not find a link between priming effects and social desirability, presenting the primes subliminally would serve as an additional control for demand characteristics. Another alternative approach could involve the use of an oddball paradigm to present affective primes. In this design, the majority of primes would be neutral or irrelevant (e.g., geometric shapes), with occasional affective primes appearing. This method could further minimize potential demand characteristics by making the affective primes less predictable and more incidental to the primary task.

Further, future research could explore using alternative stimuli as affective primes. In our studies, we used human faces due to their ecological validity; faces are highly salient in everyday life and elicit strong affective responses[69]. However, we recognize that facial attractiveness and other idiosyncratic features could introduce variability that is unrelated to the affective valence of the facial expression. To mitigate this, future studies could benefit from using more controlled, abstract representations of facial expressions (e.g., emojis).

Finally, our studies focused on the influence of short-lived affective states on choice, where incidental affect varied with each choice alternative. While this design allowed us to independently manipulate the valence of the primes presented alongside each option, it likely differs from more common scenarios where more sustained affective states, such as moods or emotions, influence consideration of all choice alternatives equally. Indeed, previous research on the role of incidental affect in choice has assumed that affect remains constant throughout the choice[62–64]. Although incidental affect may not typically vary as rapidly as modeled in our studies, integral affect—feelings directly related to the choice alternatives—would be expected to fluctuate as individuals consider each option. By manipulating incidental affect, our paradigm allowed us to isolate the *causal* role that affect plays in preference construction during choice without other confounds that would be present if we attempted to manipulate integral versus incidental affect (e.g., the value of choice alternatives).

Conclusion

In conclusion, our studies provide evidence of the effect of incidental affect on choice, and introduce a novel methodology for understanding the constructive role of affect in preference formation. In everyday life, our findings suggest that preferences and choices are more malleable and context-dependent than previously thought. This knowledge can lead to better decision-making strategies, both at an individual and an organizational level, by acknowledging the role of affect in shaping our choices. It can also inform policy-making and organizational strategies, ensuring they are more aligned with the psychological mechanisms of choice. While much work has examined the effects of cognitive contextual factors such as framing[53,54], default setting[55], or joint versus separate evaluation modes[56], affective influences on choice remain underexplored. At the same time, there has been an increasing scientific interest in decision making that is based on intuition or "gut feelings" (for reviews, see[70,71]). Our novel application of the AMP provides a basic foundation for future research investigating the role of affective feelings as an important contextual factor in preference formation and choice.

Data availability

The data that support the findings of this study and the R code used for the analysis are publicly available in the Open Science Framework repository at: https://osf.io/5nrsg/?view_only=ef28a6ee8d6b4fa7b6d7a30dac544db2.

Received: 4 June 2024; Accepted: 18 December 2024
Published online: 30 December 2024

References

1. Garg, N., Wansink, B. & Inman, J. J. The influence of incidental affect on consumers' food intake. *J. Mark.* **71**, 194–206 (2007).
2. Baumann, J. & DeSteno, D. Context explains divergent effects of anger on risk taking. *Emotion* **12**, 1196–1199 (2012).
3. Wake, S., Wormwood, J. & Satpute, A. B. The influence of fear on risk taking: a meta-analysis. *Cogn. Emot.* **34**, 1143–1159 (2020).
4. Loewenstein, G. F., Weber, E. U., Hsee, C. K. & Welch, N. Risk as feelings. *Psychol. Bull.* **127**, 267 (2001).
5. Anderson, E., Siegel, E., White, D. & Barrett, L. F. Out of sight but not out of mind: unseen affective faces influence evaluations and social impressions. *Emotion* **12**, 1210–1221 (2012).
6. Wormwood, J. B., Siegel, E. H., Kopec, J., Quigley, K. S. & Barrett, L. F. You are what I feel: a test of the affective realism hypothesis. *Emotion* **19**, 788–798 (2019).
7. Hirshleifer, D. & Shumway, T. Good day sunshine: stock returns and the weather. *J. Finance* **58**, 1009–1032 (2003).
8. Clore, G. L., Gasper, K. & Garvin, E. Affect as information. In *Handbook of affect and social cognition* (ed. Forgas, J. P.) 121–144 (Lawrence Erlbaum Associates, 2001).
9. Johnson, E. J. & Tversky, A. Affect, generalization, and the perception of risk. *J. Pers. Soc. Psychol.* **45**, 20 (1983).
10. Niedenthal, P. M. Implicit perception of affective information. *J. Exp. Soc. Psychol.* **26**, 505–527 (1990).

11. Winkielman, P., Berridge, K. C. & Wilbarger, J. L. Unconscious affective reactions to masked happy versus angry faces influence consumption behavior and judgments of value. *Pers. Soc. Psychol. Bull.* **31**, 121–135 (2005).
12. Winkielman, P., Zajonc, R. B. & Schwarz, N. Subliminal affective priming resists attributional interventions. *Cogn. Emot.* **11**, 433–465 (1997).
13. Russell, J. A. Core affect and the psychological construction of emotion. *Psychol. Rev.* **110**, 145–172 (2003).
14. Russell, J. A. A circumplex model of affect. *J. Pers. Soc. Psychol.* **39**, 1161–1178 (1980).
15. Barrett, L. F. & Russell, J. A. The structure of current affect: controversies and emerging consensus. *Curr. Dir. Psychol. Sci.* **8**, 10–14 (1999).
16. Kuppens, P., Tuerlinckx, F., Russell, J. A. & Barrett, L. F. The relation between valence and arousal in subjective experience. *Psychol. Bull.* **139**, 917 (2013).
17. Clore, G. L., Schwarz, N. & Conway, M. Affective causes and consequences of social information processing. In *Handbook of social cognition* (eds Wyer, R. S. & Srull, T. K.) 323–417 (Erlbaum, 1994).
18. Clore, G. L. Cognitive phenomenology: feelings and the construction of judgment. In *The construction of social judgments* (eds Martin, L. L. & Tesser, A.) 133–163 (Erlbaum, 1992).
19. Schwarz, N. & Clore, G. L. How do I feel about it? The informative function of affective states. In *Affect, cognition and social behavior* (eds Fiedler, K. & Forgas, J.) 44–62 (Hogrefe International, 1988).
20. Clore, G. L. & Huntsinger, J. R. How emotions inform judgment and regulate thought. *Trends Cogn. Sci.* **11**, 393–399 (2007).
21. Siegel, E. H. & Stefanucci, J. K. A little bit louder now: negative affect increases perceived loudness. *Emotion* **11**, 1006 (2011).
22. Forgas, J. P. & Bower, G. H. Mood effects on person-perception judgments. *J. Pers. Soc. Psychol.* **53**, 53–60 (1987).
23. Leder, H., Belke, B., Oeberst, A. & Augustin, D. A model of aesthetic appreciation and aesthetic judgments. *Br. J. Psychol.* **95**, 489–508 (2004).
24. Konečni, V. J. & Sargent-Pollock, D. Arousal, positive and negative affect, and preference for Renaissance and 20th-century paintings. *Motiv. Emot.* **1**, 75–93 (1977).
25. Small, D. A. & Lerner, J. S. Emotional policy: personal sadness and anger shape judgments about a welfare case. *Polit. Psychol.* **29**, 149–168 (2008).
26. Bartlett, M. Y., Condon, P., Cruz, J., Baumann, J. & DeSteno, D. Gratitude: prompting behaviours that build relationships. *Cogn. Emot.* **26**, 2–13 (2012).
27. Iyengar, S. *The Art of Choosing* (Twelve, 2010).
28. Usher, M., Tsetsos, K., Yu, E. C. & Lagnado, D. A. Dynamics of decision-making: from evidence accumulation to preference and belief. *Front. Psychol.* **4**, 758 (2013).
29. Payne, J. W. & Bettman, J. R. Walking with the scarecrow: the information-processing approach to decision research. In *Blackwell handbook of judgment and decision making* (eds Koehler, D. J. & Harvey, N.) 110–132 (Blackwell, 2004).
30. Bettman, J. R., Luce, M. F. & Payne, J. W. Constructive consumer choice processes. *J. Consum. Res.* **25**, 187–217 (1998).
31. Payne, J. W., Bettman, J. R. & Johnson, E. J. *The Adaptive Decision Maker* (Cambridge University Press, 1993).
32. Gigerenzer, G. & Goldstein, D. G. Reasoning the fast and frugal way: models of bounded rationality. *Psychol. Rev.* **103**, 650–669 (1996).
33. Simon, H. A. Rational choice and the structure of the environment. *Psychol. Rev.* **63**, 129–138 (1956).
34. Payne, J. W., Bettman, J. R. & Luce, M. F. When time is money: decision behavior under opportunity-cost time pressure. *Organ. Behav. Hum. Decis. Process.* **66**, 131–152 (1996).
35. Pham, M. T. Representativeness, relevance, and the use of feelings in decision making. *J. Consum. Res.* **25**, 144–159 (1998).
36. Schwarz, N. & Clore, G. L. Mood, misattribution, and judgments of well-being: informative and directive functions of affective states. *J. Pers. Soc. Psychol.* **45**, 513–523 (1983).
37. Slovic, P. The construction of preference. *Am. Psychol.* **50**, 364–371 (1995).
38. Lichtenstein, S. & Slovic, P. *The Construction of Preference* (Cambridge University Press, 2006).
39. Gregory, R., Lichtenstein, S. & Slovic, P. Valuing environmental resources: a constructive approach. *J. Risk Uncertain.* **7**, 177–197 (1993).
40. Payne, B. K., Cheng, C. M., Govorun, O. & Stewart, B. D. An inkblot for attitudes: affect misattribution as implicit measurement. *J. Pers. Soc. Psychol.* **89**, 277 (2005).
41. Payne, K. & Lundberg, K. The Affect Misattribution Procedure: ten years of evidence on reliability, validity, and mechanisms. *Soc. Pers. Psychol. Compass* **8**, 672–686 (2014).
42. Flexas, A. et al. Affective priming using facial expressions modulates liking for abstract art. *PLoS One* **8**, e80154 (2013).
43. Pryor, J. B., Reeder, G. D. & Monroe, A. E. The infection of bad company: stigma by association. *J. Pers. Soc. Psychol.* **102**, 224–241 (2012).
44. Gawronski, B. & Ye, Y. What drives priming effects in the affect misattribution procedure?. *Pers. Soc. Psychol. Bull.* **40**, 3–15 (2014).
45. Hughes, S., Cummins, J. & Hussey, I. Effects on the Affect Misattribution Procedure are strongly moderated by influence awareness. *Behav. Res. Methods* **55**, 1558–1586 (2022).
46. Damasio, A. R., Tranel, D. & Damasio, H. C. Somatic markers and the guidance of behavior: theory and preliminary testing. In *Frontal Lobe Function and Dysfunction* (eds Levin, H. S. et al.) 217–229 (Oxford University Press, 1991).
47. Bechara, A., Damasio, H., Tranel, D. & Damasio, A. R. Deciding advantageously before knowing the advantageous strategy. *Science* **275**, 1293–1295 (1997).
48. Bechara, A. The role of emotion in decision-making: evidence from neurological patients with orbitofrontal damage. *Brain Cogn.* **55**, 30–40 (2004).
49. Bates, D., Mächler, M., Bolker, B. & Walker, S. Fitting linear mixed-effects models using lme4. *J. Stat. Softw.* **67**, 1–48 (2015).
50. Lawrence, M. A. ez: easy analysis and visualization of factorial experiments. R package version 4.4-0 (2011).
51. Shields, S. A., Mallory, M. E. & Simon, A. The Body Awareness Questionnaire: reliability and validity. *J. Pers. Assess.* **53**, 802–815 (1989).
52. Fiene, L., Ireland, M. J. & Brownlow, C. The Interoception Sensory Questionnaire (ISQ): a scale to measure interoceptive challenges in adults. *J. Autism Dev. Disord.* **48**, 3354–3366 (2018).
53. Tversky, A. & Kahneman, D. The framing of decisions and the psychology of choice. *Science* **211**, 453–458 (1981).
54. Levin, I. P., Schneider, S. L. & Gaeth, G. J. All frames are not created equal: a typology and critical analysis of framing effects. *Organ. Behav. Hum. Decis. Process.* **76**, 149–188 (1998).
55. Johnson, E. J. & Goldstein, D. Do defaults save lives?. *Science* **302**, 1338–1339 (2003).
56. Hsee, C. K., Loewenstein, G. F., Blount, S. & Bazerman, M. H. Preference reversals between joint and separate evaluations of options: a review and theoretical analysis. *Psychol. Bull.* **125**, 576 (1999).
57. Greenwald, A. G., McGhee, D. E. & Schwartz, J. L. K. Measuring individual differences in implicit cognition: the implicit association test. *J. Pers. Soc. Psychol.* **74**, 1464–1480 (1998).
58. Payne, B. K., Burkley, M. A. & Stokes, M. B. Why do implicit and explicit attitude tests diverge? The role of structural fit. *J. Pers. Soc. Psychol.* **94**, 16 (2008).
59. Williams, A. & Steele, J. R. Examining children's implicit racial attitudes using exemplar and category-based measures. *Child Dev.* **21**, 55 (2017).
60. Mann, T. C., Cone, J., Heggeseth, B. & Ferguson, M. J. Updating implicit impressions: new evidence on intentionality and the affect misattribution procedure. *J. Pers. Soc. Psychol.* **116**, 349 (2019).

61. Katz, J. H., Mann, T. C., Shen, X., Goncalo, J. A. & Ferguson, M. J. Implicit impressions of creative people: creativity evaluation in a stigmatized domain. *Organ. Behav. Hum. Decis. Process.* **169**, 104116 (2022).
62. Schwarz, N. & Clore, G. L. Feelings and phenomenal experiences. In *Social Psychology: Handbook of Basic Principles* (eds Kruglanski, A. & Higgins, E. T.) 385–407 (Guilford, 2007).
63. Greifeneder, R., Bless, H. & Pham, M. T. When do people rely on affective and cognitive feelings in judgment? A review. *Pers. Soc. Psychol. Rev.* **15**, 107–141 (2011).
64. Schwarz, N. Feelings-as-information theory. In *Handbook of Theories of Social Psychology* (eds Van Lange, P. A. M. et al.) 289–308 (Sage, 2012).
65. de Bruin, W. B. Save the last dance for me: unwanted serial position effects in jury evaluations. *Acta Psychol.* **118**, 245–260 (2005).
66. de Bruin, W. B. Save the last dance II: unwanted serial position effects in figure skating judgments. *Acta Psychol.* **123**, 299–311 (2006).
67. Li, Y. E. & Epley, N. When the best appears to be saved for last: serial position effects on choice. *J. Behav. Decis. Mak.* **22**, 378–389 (2009).
68. Tsuchiya, N. & Koch, C. Continuous flash suppression reduces negative afterimages. *Nat. Neurosci.* **8**, 1096–1101 (2005).
69. Adolphs, R. Recognizing emotion from facial expressions: psychological and neurological mechanisms. *Behav. Cogn. Neurosci. Rev.* **1**, 21–62 (2002).
70. Newell, B. R. & Shanks, D. R. Unconscious influences on decision making: a critical review. *Behav. Brain Sci.* **37**, 1–19 (2014).
71. Hollands, G. J., Marteau, T. M. & Fletcher, P. C. Non-conscious processes in changing health-related behaviour: a conceptual analysis and framework. *Health Psychol. Rev.* **10**, 381–394 (2016).

Author contributions

EK, ER, and JW designed the research. EK performed the studies, analyzed the data, and wrote the manuscript. All authors reviewed and edited the manuscript.

Declarations

Competing interests

The authors declare no competing interests.

Additional information

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1038/s41598-024-83935-x.

Correspondence and requests for materials should be addressed to E.K.

Reprints and permissions information is available at www.nature.com/reprints.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.