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DOI:
[10.1111/bjhp.12691](https://doi.org/10.1111/bjhp.12691)

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Document Version
Publisher's PDF, also known as Version of record

Citation for published version (Harvard):
Lorimer, S, McCormack, T, Hoerl, C, Johnston, M, Beck, SR & Feeney, A 2023, 'Do both anticipated relief and anticipated regret predict decisions about influenza vaccination?', *British Journal of Health Psychology*.
<https://doi.org/10.1111/bjhp.12691>

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ARTICLE

Do both anticipated relief and anticipated regret predict decisions about influenza vaccination?

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Abstract

Objective: Anticipated regret has been found to predict vaccination intentions and behaviours. We examined whether anticipated relief also predicts seasonal influenza vaccination intentions and behaviour. Given claims about differences in their antecedents and function, we distinguished between counterfactual relief (relief that a worse outcome did not obtain) and temporal relief (relief that an unpleasant experience is over).

Design: Cross-sectional.

Methods: Unvaccinated participants ($N=295$) were recruited online in November 2020. Participants completed measures of anticipated regret, anticipated counterfactual relief, and anticipated temporal relief and measures of theory of planned behaviour constructs (attitudes, norms, perceived control, and intentions). One month later, the same participants were re-surveyed and asked to report their vaccination status.

Results: Although all anticipated emotion measures were associated with intentions and behaviour, only anticipated counterfactual relief and regret independently predicted vaccination intentions in regression analyses. Mediation analysis showed both anticipated counterfactual relief and regret were indirectly, via intentions, associated with behaviour.

Conclusions: Results suggest that, regardless of valence, counterfactual emotions predict vaccination intention and, indirectly, behaviour. Furthermore, participants may differ in their sensitivity to the anticipation of positive versus negative counterfactual emotions. These findings may permit more precise targeting of interventions to increase vaccine uptake.

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KEYWORDS

cognitive psychology, decision-making, emotions, intention, vaccination

Statement of contribution**What is already known on this subject?**

- Relatively large proportions of people do not avail of vaccines designed to protect them from disease.
- Although anticipated regret predicts vaccination intention and behaviour, mechanisms are unclear.
- It has been suggested that anticipated relief may also be important for health decisions.

What does this study add?

- Counterfactual, but not temporal relief was associated with vaccination intention and behaviour.
- Anticipated counterfactual relief and regret were independently associated with outcome variables.
- Individuals may differ in their sensitivity to anticipation of positive and negative consequences of behaviour.

BACKGROUND

Vaccines are important in our attempt to protect public health and health services from the effects of infectious disease. However, large proportions of people do not avail themselves of vaccines against diseases such as COVID-19, seasonal influenza, and HPV. Arguably, the importance of understanding the factors that influence people's vaccination decisions is increasing in light of surges in vaccine-preventable diseases such as measles (Hotez et al., 2020), as well as the recent COVID-19 pandemic in which vaccine hesitancy was a worldwide issue (Sallam, 2021). Psychological research has explored a range of ways in which people's intentions and behaviour around getting vaccinated might be understood (see Brewer et al., 2017). Such understanding may facilitate the development of interventions to encourage vaccine uptake. Various routes to increasing vaccination rates have been explored including educational programmes designed to address misinformation (see Whitehead et al., 2023 for review) and nudges designed to alter the decision-making context to encourage vaccine uptake (see Reñosa et al., 2021 for review). One of the most promising routes to increasing vaccination rates seems to be direct attempts to change the behaviour of people who have expressed the intention to be vaccinated through prompts, primes, and incentives (Brewer et al., 2017). However, vaccination intentions themselves are also strongly associated with both cognitive and social factors.

An important cognitive factor implicated in people's vaccination intentions and decisions is their appraisal of the risks associated with vaccination and non-vaccination. We focus on the emotions people anticipate experiencing about their decision, which are linked to people's risk appraisal and are known to predict vaccine intentions and behaviour (for meta-analyses, see Brewer et al., 2016; Sandberg & Conner, 2008). Note here the distinction between *anticipated* emotions, emotions that one might feel in the future if one acts in a certain way in the present, and *anticipatory* emotions, which are emotions experienced in the present when thinking about a possible future occurrence (for discussion, see Baumgartner et al., 2008). Although anticipated and anticipatory emotions may be linked insofar as anticipating

future regret, for example, may result in present worry, in the current investigation, we focus on the impact of anticipated emotions. The vast majority of the relevant extant literature concerning anticipated emotions focuses on anticipated regret. Here, we expand the study of anticipated emotions in the context of vaccination to include anticipated relief. In doing so, we hope to (1) extend understanding of the determinants of vaccine intentions and behaviour, (2) shed light on why anticipated regret predicts vaccine intentions so well, and (3) test recent theoretical claims about the nature and function of relief.

Anticipated regret and health

Anticipated regret is the most commonly studied emotion in the context of vaccination intentions and behaviour and predicts both better than other anticipated emotions or measures of other elements of risk appraisal such as the perceived likelihood or severity of outcomes (Brewer et al., 2016). Regret is an unpleasant emotion experienced upon the realization that a different decision would have brought about a better outcome (Landman, 1993). Anticipating regret about the consequences of a vaccination decision may predict people's intentions and behaviour because it captures at least two important elements of their appraisal of the risk inherent in the decision. The invitation to anticipate regret requires one first to consider the likelihood of a particular decision turning out badly and second, one's likely emotional response to that outcome (see Sheeran et al., 2014). Anticipated regret about decisions not to get vaccinated is known to predict intentions and behaviours related to vaccines for HPV (e.g., Christy et al., 2016; Pența et al., 2020), seasonal influenza (e.g., Chapman & Coups, 2006; Liao et al., 2013), and COVID-19 (e.g., Wolff, 2021).

It is still unclear why the regret that people anticipate arising out of decisions around vaccination should predict their intentions so well. Accounts of decision-making which highlight the importance of anticipated regret (e.g., Loomes & Sugden, 1982; Zeelenberg & Pieters, 2007) claim that, given the aversive nature of regret, individuals are motivated to prevent or minimize the occurrence of future regret. One way that this can be achieved is by anticipating future regret and selecting the behaviour for which no or less regret is anticipated, thus creating a tight relation between anticipated regret and behavioural intention. Within the context of vaccinations, Brewer et al. (2017) speculated that the anticipation of regret may tap into a potent mix of affect and cognition. Indeed, models of the role of risk appraisal in vaccination decision-making tend to include negative affect as a causal factor. Negative affect includes worry, fear, and anxiety which may all be currently experienced whilst considering the prospect of experiencing regret in the future. On the other hand, Brewer et al. (2017) also speculated that the predictive power of anticipated regret may derive from its requirement that people mentally simulate the possible consequences of a vaccination decision. Currently, there are no data that allow us to arbitrate between these possibilities.

Extending the study of anticipated counterfactual emotions: Anticipated relief

In the current study, we expanded the study of anticipated emotions and vaccination decision-making to include anticipated relief. Relief is a positive emotion experienced when something unpleasant is avoided or comes to an end. Although relief has played a theoretically significant role in a variety of research contexts (e.g., Gratz et al., 2016; Porreca & Navratilova, 2017; Wood & Griffiths, 2007), research designed specifically to explore the antecedents, nature, and function of relief is sparse. The study of relief is complicated by the fact that the term is used to denote an emotion that can arise in two different situations: (1) upon realizing that one's current state is more favourable than a possible alternative, for example, when making it just in time for a flight, rather than missing the flight, or (2) when an aversive episode is over, for example, at the end of an unpleasant dental procedure. Following Hoerl (2015), we refer to the relief experienced in the first type of situation as *counterfactual relief* and to the relief experienced in the second type of situation as *temporal relief*. Counterfactual relief is occasioned by a downward

comparison between an actual state of affairs and a worse counterfactual state of affairs (see Deutsch et al., 2015; Hoerl, 2015; Sweeny & Vohs, 2012). Because of this reliance on counterfactual thinking, counterfactual relief has a precursor that is analogous to regret whereas temporal relief does not and derives instead from the awareness that an aversive experience is now in the past. Recent evidence suggests that the relief experienced in these two types of situations varies in psychologically meaningful ways (Graham et al., 2022; Lorimer et al., 2021; Sweeny & Vohs, 2012).

In our study, we examined whether asking people to anticipate relief experiences associated with decisions to get vaccinated would predict their vaccination intentions and behaviours. To date, only one study has explored the association between anticipated relief, intention, and health behaviour. Shepherd et al. (2017) asked male participants to indicate the extent to which they would feel (1) relieved if they did perform testicular self-examination and (2) regret if they did not perform testicular self-examination. Results indicated that, when controlling for theory of planned behaviour variables, anticipated relief was positively associated with both self-examination intention and past behaviour. However, in terms of the distinction drawn above, it is unclear whether participants' relief ratings reflected anticipated counterfactual relief (relief that they had performed self-examination rather than not) or temporal relief (relief that once they had performed the potentially aversive (McClenahan et al., 2007) self-examination, it would be over). Nonetheless, Shepherd et al.'s study is important because it provides the first evidence linking anticipated relief to both past behaviour and future intention.

Apart from being of interest in its own right, studying the association between anticipated relief and vaccination intentions also has the potential to shed light on exactly why, in existing studies, asking people to anticipate regret has predicted their intentions or behaviour. Anticipating negative affect (e.g., regret) may be a more crucial factor as it primes anticipatory negative emotions such as worry or anxiety (Bagozzi & Pieters, 1998). If this is the case, then we might not expect anticipation of relief to be predictive of vaccination intentions or behaviour. On the other hand, if mental simulation, that is, the process of engaging in mental time travel to imagine and compare various futures in which they have or have not engaged in certain behaviours (see Kahneman et al., 1982), is pertinent, then we might expect the anticipation of relief to be just as predictive as the anticipation of regret.

In addition, studying anticipated relief in this context may reveal something about the function of relief. The consensus within the literature is that anticipation and experience of counterfactual emotions influence future decision-making (e.g., Epstude & Roese, 2008; Zeelenberg & Pieters, 2007). According to this view, we might expect anticipation of counterfactual relief to predict vaccine intentions and behaviours. However, much less attention has been paid to the possible functions of temporal relief. Both Sweeny and Vohs (2012) and Hoerl (2015) suggest a positive link between temporal relief and engagement in aversive but ultimately beneficial behaviours. Sweeny and Vohs (2012) propose that context-specific experiences of temporal relief form the basis of future engagement in the behaviours which gave rise to the temporal relief through a learning process. In contrast, Hoerl (2015) suggests that it is the anticipation of temporal relief which may motivate people to engage in behaviours that are intrinsically aversive but ultimately beneficial. Under this view, the anticipation of temporal relief does not necessarily require generalization from previous experience. Regardless of the differences in these claims, under either view, the anticipation of temporal relief should also predict vaccine intentions and behaviour.

The current study

In our study, we examined relations between anticipated counterfactual and temporal relief, anticipated regret, and intentions and decisions about whether to get the seasonal flu vaccine. There is strong evidence from a variety of cultures that anticipated regret is associated with people's intentions and decisions to avail themselves of the flu vaccine (e.g., Chapman & Coups, 2006; Liao

et al., 2013; Myers & Goodwin, 2011). However, there has been no study of the relations between these outcome variables and anticipated relief, nor has any study distinguished between anticipated counterfactual and temporal relief. Although our primary interest was in the predictive power of the anticipated emotions, we also collected data on measures of the variables in the theory of planned behaviour (TPB; Azjen, 1991), so that in a subsidiary analysis we could examine the extent to which ratings of anticipated emotions continued to predict intentions once those variables had been controlled for. We report a study that was run in the United Kingdom early in the winter of 2020, at which time the UK government was encouraging people to avail themselves of the flu vaccine and had made it freely available to a larger section of the population than in previous years. At Time 1, we surveyed people who had not yet been vaccinated about their intentions to do so and asked them to complete an anticipated emotion and TPB questionnaire. We surveyed them again 1 month later, at Time 2, about whether they had been vaccinated. We predicted that ratings of anticipated regret and counterfactual relief would be positively associated with vaccination intentions and behaviour but also, based on Hoerl's (2015) account of the function of anticipated temporal relief, that temporal relief would also predict intentions and behaviour.

METHODS

Participants

At Time 1 (19 November 2020), 295 adult participants (68.5% female, $M_{\text{age}} = 32.6$ years, $SD_{\text{age}} = 10.9$), who had not yet received the seasonal flu vaccine were recruited via Prolific (<https://www.prolific.co/>). Only those residing in the United Kingdom were eligible to take part. The same participants were contacted at Time 2 (15 December 2020). Seventy-eight per cent ($N = 229$, 70.3% female, $M_{\text{age}} = 33.2$ years, $SD_{\text{age}} = 11.2$) of the participants completed the Time 2 questionnaire.

We intended to use binary logistic regression to analyse whether people reported having been vaccinated at Time 2. Calculation of sample size for a hierarchical binary logistic regression is not straightforward, and debate exists concerning how best to estimate the required sample size for this analysis. One approach is to base the sample size on events per variable in the smallest cell of the outcome variable. At the time, we did not have an appropriate estimate of vaccination uptake in the general population of the United Kingdom, so it was not possible to estimate sample size in this way. To satisfy Vittinghoff and McCulloch's (2007) recommendation of five observations per predictor for the smallest cell of the outcome variable (non-vaccination), we need to be able to include 135 participants in that analysis. Because we could not predict how many participants would return at Time 2, nor how many would decide to be vaccinated, we surveyed more than double that number at Time 1. An alternative approach to sample size determination for binary logistic regression determines the sample size required for a test of just one key variable of interest and additional covariates. Although our study has more than one such key variable, nonetheless we used G*Power 3 (Faul et al., 2007) to calculate the sample size required to detect an odds ratio of 1.92 whilst considering an R^2 value of .27 when all predictors are included (OR and R^2 values were derived from Shepherd et al., 2017). Results showed a minimum of 183 participants were required to achieve power of .80. Thus, our sample size allowed us to satisfy Vittinghoff and McCulloch's (2007) recommendations about number of observations per predictor variable and the requirements of the reported power analysis.

Participants received £1.25 (UK pounds) for participation at Time 1 and £.50 (UK pounds) for participation at Time 2. Differences between those who responded at Time 1 and those who did not respond at Time 2 are presented in S1; no notable differences between these groups were observed with respect to anticipated emotions. Ethical approval was granted by the Research Ethics Committee of the first author's university.

TABLE 1 Means, standard deviations, and partial correlations (controlling for TPB constructs) of key variables.

	M (SD)	1	2	3	4
Temporal relief	4.89 (1.66)	–			
Counterfactual relief	3.96 (1.86)	.144*	–		
Regret	2.74 (1.67)	.31***	.30***	–	
Intention	3.13 (1.91)	.18**	.31***	.51***	–
Time 2 vaccination status	N/A	.10	.14*	.20**	.36***

Note: All variables were measured on a scale from 1 to 7. Vaccination status coded as 0 = not vaccinated and 1 = vaccinated. $N = 295$ except for associations with Time 2 vaccination status, where $N = 229$. Significance codes: *** $p < .001$, ** $p < .01$, and * $p < .05$.

Materials and procedure

Questionnaires were administered on Qualtrics (<https://www.qualtrics.com/uk/>). At Time 1, participants first answered questions regarding their age, gender, level of education, eligibility for a free seasonal flu vaccination, and whether they had been vaccinated the year before. Following a brief description of the seasonal flu, participants answered questions about the variables in TPB: attitudes (4 items); subjective norms (4 items); and perceived control (3 items). Questions were formulated using Francis et al.'s (2004) TPB questionnaire manual; all responses were given on a 7-point scale from “strongly disagree” to “strongly agree.”

Following this, participants completed questions assessing anticipated temporal relief, anticipated counterfactual relief, and anticipated regret. Two questions were used to assess each of anticipated temporal relief (e.g., “If I got the flu jab before 15 December 2020, I would feel relieved once the appointment was over,” $a = .95$), anticipated counterfactual relief (e.g., “If I got the flu jab before 15 December 2020, rather than not getting it, I would feel relieved,” $a = .95$), and anticipated regret (e.g., “If I did not get the flu jab before 15 December 2020, rather than getting it, I would feel regret,” $a = .90$).¹ Finally, participants were asked about their intention to get the flu jab before 15 December 2020 (3 items, $a = .93$). Prior to consenting to take part at Time 1, participants were informed that they would be invited to take part in the follow-up on 15 December 2020. At Time 2, original participants were recontacted and asked whether they had been vaccinated.

RESULTS

Means, standard deviations, and inter-correlations of all key variables are provided in the Data S1. Table 1 shows the partial correlations between the three anticipated affective states, intention, and behaviour whilst controlling for the TPB constructs. Notably, the partial correlations revealed that although anticipated counterfactual relief was positively associated with anticipated temporal relief and with anticipated regret, its association with anticipated regret was significantly stronger than its association with anticipated temporal relief ($z = -2.32$, $p = .02$; Hittner et al., 2003). A comparison of the correlations between the three anticipated affective states and intention indicates that the association between anticipated regret and intention was significantly stronger than the association between intention and either anticipated counterfactual relief ($z = 3.30$, $p = .001$) or anticipated temporal relief ($z = 5.31$, $p < .001$). The associations between anticipated counterfactual relief and intention, and anticipated temporal relief and intention were similar ($z = 1.77$, $p = .076$).

At Time 1, 19% of participants reported being vaccinated the year before, and 22% of participants reported entitlement to a free vaccination. Of participants who responded at Time 2, 18% were vaccinated by

¹ Confirmatory factor analysis (see DataS1) of responses to the six anticipated emotion questions indicated a three-factor solution, aligned with the three targeted constructs, was the best fit for these items.

that stage. Vaccination status at Time 2 was positively associated with both vaccination the previous year, $\chi^2(1, 229) = 49.8, p < .001$, and entitlement to a free vaccination, $\chi^2(1, 229) = 20.8, p < .001$.

Predicting vaccination intentions

A three-step linear regression was used to determine the variance in vaccination intention that could be accounted for by anticipated temporal relief and anticipated counterfactual relief whilst controlling for anticipated regret and TPB constructs (see Table 2). Anticipated temporal relief and anticipated counterfactual relief were entered at Step 1, followed by the addition of anticipated regret at Step 2, and the TPB variables at Step 3. Although it is common in the TPB literature for TPB variables to be entered first, our approach provides a clearer picture of how the predictive value of the two relief variables, not previously explored in this way, vary with the addition of well-established predictors. The final model, containing all predictor variables, allows for a comparison with previous TPB studies.² To examine the variance in intention predicted by each type of anticipated relief when controlling for the other, anticipated temporal relief and anticipated counterfactual relief were both added at Step 1. Both variables were significant, positive predictors of intention, and together accounted for 34% of the variance in intention. The addition of anticipated regret at Step 2 further improved the model, accounting for a further 25% of variance. At Step 2, anticipated counterfactual relief and anticipated regret were significant, positive predictors of intention, whilst anticipated temporal relief became non-significant. The TPB constructs were entered at Step 3 and accounted for a further 14% of the variance in vaccination intention. At this step, anticipated counterfactual relief and anticipated regret remained significant, positive predictors of intention. Attitudes, subjective norms, and perceived control were also significant, positive predictors of intention.

Predicting vaccination status

Examination of the inter-correlations in Table 1 reveals that anticipated temporal relief, anticipated counterfactual relief, and anticipated regret were significantly associated with vaccination status at Time 2. A three-step binary logistic regression (see Table 2 for summary) determined whether anticipated temporal relief and anticipated counterfactual relief were significant predictors of vaccination behaviour whilst controlling for the predictive effects of anticipated regret and the TPB constructs, including intention. To examine the variance in vaccination status independently explained by anticipated temporal relief and anticipated counterfactual relief, these variables were entered at Step 1, resulting in a significant improvement compared to a model based on chance and producing a pseudo R^2 (Nagelkerke) of .21. At Step 1, both anticipated temporal relief and anticipated counterfactual relief were significant, positive predictors of vaccination status. Anticipated regret was entered at Step 2, which improved the model further, $R^2 = .28$. At Step 2, only anticipated counterfactual relief and anticipated regret were significant predictors of vaccination status. The TPB constructs, now including intention, were entered at Step 3. This offered further improvement to a model ($R^2 = .47$). At this final step, only intention was a significant predictor of behaviour.

The partial correlations and regression model indicate a relation between (1) anticipated regret, and intention and vaccination behaviour, and (2) anticipated counterfactual relief and intention and vaccination behaviour. However, the regression analysis indicates that neither anticipated regret nor anticipated counterfactual relief predicts behaviour in the presence of the intention measure. With this in mind, a series of bootstrap-based mediation analyses (PROCESS, Hayes, 2022) were performed to determine whether indirect relations exist between (1) anticipated counterfactual relief and behaviour through intention, and (2) anticipated regret and behaviour through intention, when controlling for TPB constructs and the other anticipated affective states. The results, depicted in Figure 1, revealed an indirect

² For the interested reader, we have reported an alternative stepwise regression model in Data S1. This additional analysis adopts the approach typically used by theory of planned behaviour researchers, entering TPB variables at Step 1 and then progressively adding additional predictors in later steps.

TABLE 2 Summary of hierarchical regression models predicting vaccination intention and Time 2 vaccination status.

	Vaccination intention						Vaccination status at Time 2								
	Step 1		Step 2		Step 3		Step 1		Step 2		Step 3				
	B (SE)	CI 95%	β	B (SE)	CI 95%	β	B (SE)	CI 95%	β	B (SE)	CI 95%	OR			
Temporal relief	.28 (.06)	.17-.39	.25***	.04 (.05)	-.06-.13	.03	.02 (.04)	-.06-.09	.01	.34 (.14)	.07-.62	1.41*	.12 (.20)	-.26-.51	1.13
Counter-factual relief	.48 (.05)	.38-.58	.47***	.20 (.05)	.12-.29	.20***	.13 (.04)	.05-.20	.12***	.46 (.12)	.22-.69	1.58***	.31 (.13)	.06-.56	1.36*
Regret				.73 (.05)	.62-.83	.64***	.43 (.05)	.33-.53	.38***	.48 (.14)	.20-.75	1.61**	-.08 (.19)	-.45-.30	.93
Attitudes						.12**	.18 (.06)	.07-.30					-.25 (.26)	-.77-.26	.78
Norms						.38***	.45 (.05)	.36-.55	.38***				.37 (.21)	.04-.77	1.44
Control						.13***	.16 (.04)	.08-.24	.13***				-.08 (.16)	-.39-.24	.93
Intention										.21			.47		
R ²	.34		.59			.73				.28					
F change	77.8***		181.7***			48.6***									
Step χ^2															35.0***

Note: Nagelkerke R² is reported for behaviour regression. *** $p < .001$, ** $p < .01$, and * $p < .05$.

Abbreviations: CI, confidence interval; OR, odds ratio.

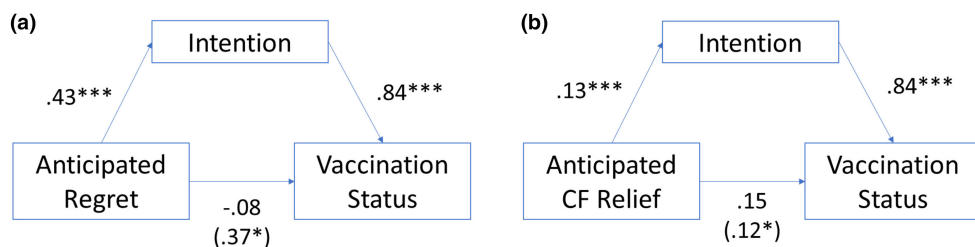


FIGURE 1 Bootstrapped mediation analyses (PROCESS; Hayes, 2022) testing direct and indirect (in parentheses) effects of (a) anticipated regret and (b) anticipated counterfactual relief on behaviour whilst controlling for theory of planned behaviour constructs and non-target anticipated emotions.

effect of anticipated regret on behaviour through intention: $\beta = .37$, bootstrapped $SE = .14$, 95% bootstrapped CI [.18, .72]. A similar indirect effect of anticipated counterfactual relief on behaviour, through intention, was observed: $\beta = .12$, bootstrapped $SE = .059$, 95% bootstrapped CI [.038, .27]. See DataS1 for full account.

DISCUSSION

The results demonstrate that counterfactual relief and regret are independently associated with people's intentions to avail themselves of the seasonal flu vaccine and, in the absence of other predictors, subsequent self-reported vaccine status. When TPB variables are controlled for, the anticipated counterfactual emotions independently predict intentions, but not vaccination status. There is, however, an indirect association between both anticipated counterfactual emotions and vaccination status that operates through intentions even when controlling for TPB variables and non-target affective states. Importantly, although the partial correlation between anticipated temporal relief and intention is statistically significant, once anticipated regret is controlled for in a regression analysis, anticipated temporal relief no longer predicts intention. Thus, our results are initial evidence that whilst anticipated relief predicts vaccine intentions, and is indirectly associated with behaviour via intention, this is only true of counterfactual relief and not also, as predicted by Hoerl (2015), of temporal relief.

The anticipation of regret is well known to predict people's vaccination intentions and, in some studies, their subsequent vaccination status. Our study demonstrates that the anticipation of relief is also predictive of such outcome variables. Strikingly, we observed that ratings of anticipated regret and anticipated relief independently predicted variance in vaccine intentions and, indirectly, subsequent self-reported vaccine status. Notably, these findings are confined to anticipated counterfactual relief, the relief one might feel having decided to be vaccinated rather than deciding not to be vaccinated; anticipated temporal relief did not predict vaccine intentions once anticipated regret had been controlled for. Thus, as well as shedding light on the determinants of vaccination intentions, our results have implications for the theoretical understanding of the function of relief as well as its relation to regret.

The theory of regret regulation (Zeelenberg & Pieters, 2007) suggests that people are motivated to engage in behaviours that will minimize the possibility or intensity of future regret. Our results reinforce this claim by replicating the well-established connection between anticipated regret, and intention and behaviour. Interestingly, however, our findings suggest that people may also be motivated to engage in behaviours that allow them to obtain or maximize positive affect in the form of relief. Further work will be required to understand how anticipated regret and relief are balanced in the decision-making process. We outlined two accounts of why the anticipation of regret might predict vaccination intentions and behaviour: (1) that it is the combination of the cognitive and affective processes required to anticipate regret, which is important because anticipating regret gives rise to anticipatory emotions such as anxiety or worry; or (2) that it is the requirement that people simulate hypothetical outcomes that is important. One interpretation of our results is that they support the second of these possible explanations.

In particular, the observation of significant associations between ratings of both anticipated regret and counterfactual relief—a negative and positive emotion, respectively—and our outcome variables might be taken to support the claim that these emotions capture variance in intentions and behaviour because they are counterfactual.

However, our results are problematic for this interpretation. We found that anticipated regret and anticipated counterfactual relief independently predict variance in (1) vaccine intentions, even when TPB variables are controlled for, and (2) self-reported vaccination status, before TPB variables are entered into the model. If their status as counterfactual emotions alone is responsible for the predictive power of anticipated regret and anticipated counterfactual relief, then we would not have observed that each independently predicts variance. Therefore, a more likely account of these results is that whilst counterfactual thinking is important, so too is the valence of the possibilities considered (i.e., whether one is considering positive or negative consequences). There are at least two possible versions of this account. First, the measure of anticipated counterfactual relief may capture additional variance in the intentions and behaviours of a subset of people whose decisions are driven by consideration of the consequences of their decisions. However, the finding that having a predisposition to prevent negative outcomes is associated with anticipating regret related to vaccination decisions (Leder et al., 2015) appears problematic for this interpretation as it seems intuitively unlikely that prevention focus would be similarly related to anticipated relief. That being said, Leder and colleagues did not assess anticipated positive affect (e.g., relief) and so it remains unclear whether a predisposition to attain positive outcomes through engagement in goal-aligned behaviours (i.e., a promotion focus) is associated with the anticipation of positive affect such as relief.

An alternative possibility is that people may differ in the extent to which their intention to get vaccinated is driven by consideration of the potential positive or negative emotional consequences of vaccination. There are individual differences in the extent to which people are subject to valence biases when generating behavioural intentions in novel situations (for a review, see Fazio et al., 2015). That is, some decision-makers weight the similarity of aspects of the current decision to negative exemplars in memory more heavily than they do similarity to positive exemplars, whereas others show the opposite pattern. Accordingly, anticipated regret may predict more variance in the intentions of people with a negative valence bias whilst anticipated counterfactual relief may predict more variance in people with a positive valence bias. If this account of our results is correct, then asking participants to anticipate counterfactual relief and regret may allow for more fine-grained predictions of their intentions.

Our results suggest that it may be possible to integrate anticipated regret and anticipated relief into interventions designed to increase vaccination uptake. One way that this could be achieved is by making these anticipated emotions salient to vaccination candidates. There is some evidence to suggest that merely asking participants to consider their future regret, that is, drawing their attention to the possibility of experiencing this emotion in the future, can increase engagement in health screening behaviours (Sandberg & Conner, 2009). However, there is variation in how effective this type of intervention may be. For example, Sandberg and Conner (2009) found that this type of intervention effectively increased cervical screening attendance for high intenders but not for those with little-to-no intention to engage in the target behaviour. The opposite pattern of results, however, was observed by O'Carroll et al. (2016) who employed a similar intervention in the context of colorectal cancer screening. Though promising, the variation in results suggests that further work is required to hone interventions that make salient anticipated emotions. In line with the suggestions of how these anticipated emotions may relate to intention, future interventions may seek to increase vaccination behaviour by drawing attention to both anticipated negative affect (regret) and anticipated positive affect (relief) within the same individuals in the hopes of an additive effect. Alternatively, it may be more effective to first determine whether there are individual differences in the extent to which participants are motivated by the two emotions and then tailor interventions to suit the valence preference of the individual. That is, individuals who are motivated by a desire to obtain positively valenced emotions could have their attention drawn to their anticipated counterfactual relief, whereas those who desire the avoidance of negative affect may have their attention drawn to their anticipated regret.

As well as having potentially important implications for intervention design around vaccination and other health-related decision-making, our results have important implications for accounts of relief. Consistent with recent accounts which hold that counterfactual relief (relief experienced when a bad outcome is avoided), differs in important ways from temporal relief (experienced when an unpleasant experience comes to an end; Deutsch et al., 2015; Hoerl, 2015; Sweeny & Vohs, 2012), our results suggest that counterfactual and temporal relief may have different functions. Whilst our results suggest that the effects of their anticipation may explain at least part of the function of counterfactual relief and regret, they do not offer strong support for the theoretical claim that anticipated temporal relief may also serve the function of helping people to decide to undergo unpleasant, but ultimately beneficial actions (Hoerl, 2015). Although the distinction between the two types of precursors to relief has been made a number of times in the recent literature, there is very little extant evidence about the nature of the difference between the resulting affective states (see Graham et al., 2022; Lorimer et al., 2021; Sweeny & Vohs, 2012), and none at all about differences in their function. Our results, for the first time, suggest that anticipated counterfactual and temporal relief may not serve the same function.

It is clear that our study demonstrates that the anticipation of temporal relief does not have the same potential importance as anticipated counterfactual relief in helping people to undergo the aversive but ultimately beneficial effects of vaccination. One possible explanation of this is that participants may not view the vaccination process as aversive enough to elicit temporal relief upon completion. Although fear of needles is a commonly cited reason for not being vaccinated (e.g., Johnson et al., 2008) suggesting there is an inherent aversiveness to the vaccination process, future work will be necessary to understand the relation between vaccination aversiveness and post-vaccination relief intensity, and how this relation influences intention and behaviour. There may, however, be other health-related behaviours which might be more likely to be motivated by the anticipation of temporal relief. For example, the end of a vaccination appointment may not necessarily indicate the end of aversive episodes associated with the vaccination process as there may be lingering apprehension about potential side effects that may be even more unpleasant than the brief sting of an injection. The anticipation of temporal relief may have a stronger association with beneficial behaviours that have highly contained or specific aversive elements. Furthermore, the end of a vaccination appointment is not correlated with its outcome, and it may be that relief experienced at the end of an event is particularly important when it signals that the outcome of the decision to undergo the experience was worth the aversiveness of the experience itself (see Frederickson, 2000). Perhaps other behaviours, such as undergoing a diagnostic medical test, where the end of the experience coincides with its outcome, would be associated with anticipated temporal relief to a greater extent. We note that in the regression analysis reported by Shepherd et al. (2017), anticipated relief, but not anticipated regret, was found to predict testicular self-examination intentions and behaviour in men. Unfortunately, Shepherd et al. did not distinguish between anticipated counterfactual and temporal relief, but it is possible that participants in that study were anticipating temporal relief at the end of their self-examination. Another way in which anticipated temporal relief may increase the likelihood of healthful behaviour is when a decision has been made and its aversive consequences are already being experienced. Thus, anticipating temporal relief may not help us decide to start a new fitness regime, but once we have made the decision to do so it may help us finish a particularly gruelling workout. Before concluding that anticipated temporal relief is not relevant to predicting health-related behaviours, it may be important to examine the role of anticipated temporal relief in a range of other health-related decision contexts that have different features than vaccination, both prior to the decision and whilst decisions are being carried out.

In addition to the nature of the vaccination context, there are a number of other issues that need to be borne in mind when interpreting our results. In particular, we relied on self-report measures of vaccination status at Time 2 and participants may have over-reported getting vaccinated. Relatedly, we examined vaccination status only 1 month after measuring the other variables in the study, whereas a longer interval between measurements is common in the literature (e.g., Chapman & Coups, 2006; Liao et al., 2013). The overall vaccination rate for our study was just under 20%, which is considerably less than the overall vaccination rates in England (Public Health England, 2021) and Scotland (Health

Protection Scotland, 2021) for 2020–2021. That being said, these data relate specifically to “at-risk” groups (e.g., people with chronic illness). Our data are more closely aligned with figures published by Blank et al. (2008), which showed a vaccination rate of ~26% in the general population. Although we surveyed participants at a time when they were most likely to be vaccinated, leaving a substantially longer interval probably would have somewhat increased the vaccination rate we observed. It is unclear, however, whether a longer interval would have affected the strength of the associations we observed. Another consideration relating to the timing of the study is that data collection took place in late 2020 at the height of the COVID-19 pandemic. With this in mind, there may have been external factors (e.g., lockdowns and isolations) that meant people who intended to do so could not get vaccinated. However, 59% of participants who were not vaccinated by Time 2 reported that the reason that they had not been vaccinated was that they simply decided not to (see DataS1 for further information). Finally, we acknowledge that even when all measured predictors are included in the regression analysis predicting behaviour, the majority of variance (53%) is still left unaccounted for. Further work, therefore, is necessary to determine the predictors of vaccination behaviour that exist beyond those measured in the current work. One possible starting point may be the probing of the full range of behaviour and emotion combinations, that is, regret about vaccination and relief about not getting vaccinated. Whilst we opted to probe expected emotions in line with vaccination as the prescriptive norm (i.e., we asked participants to anticipate relief as the result of action, or *getting* vaccinated, and regret from inaction, or *not getting* vaccinated), past research on regret has explored anticipated regret for both action and inaction and found that the two measures are independently associated with vaccination intention (e.g., Reiter et al., 2011). Although no research has explored anticipated relief for both action and inaction, it seems reasonable to expect that probing both may account for additional variance in a similar fashion as regret.

Additionally, the cross-sectional nature of the present study limits our ability to make strong claims regarding causal mechanisms. Specifically, although our consideration and treatment of anticipated emotions as predictors of intention and, by extension, behaviour are based on previous research that has positioned them as such, we acknowledge that the process of measuring anticipated emotions and intentions concurrently results in ambiguity over the direction of causation and thus limits the interpretability of the indirect effects of anticipated emotions on behaviour. This issue is pervasive in studies of anticipated emotions, which typically assess such emotions alongside intentions and often fail to follow up on actual behaviour. Although the present study assesses both intention and behaviour, future work could experimentally manipulate the salience of anticipated emotions and measure intentions and behaviour across multiple time points. Doing so would, arguably, facilitate more confident claims concerning causal mechanisms.

In conclusion, our results suggest that anticipated counterfactual relief and regret are both associated with flu vaccination intentions and, indirectly, behaviours. That a positive and a negative counterfactual emotion predict vaccination intentions and behaviour suggests that it is their common basis in counterfactual thinking which underlies their predictive power. However, the finding that each anticipated emotion independently predicted the outcome variables suggests that people may differ in the weight they attach to the anticipated negative versus positive consequences of a decision to be vaccinated when forming behavioural intentions. The anticipation of temporal relief, which we found not to be as predictive of vaccination intentions or behaviour, does not involve consideration of either positive or negative consequences of a vaccination decision. Thus, it may be consideration of consequences specifically that underlies the predictiveness of anticipated counterfactual emotions. Knowing whether someone's intention to get vaccinated is most heavily influenced by consideration of negative versus positive consequences is likely to be important when designing interventions to help people turn their vaccination intentions into behaviour.

AUTHOR CONTRIBUTIONS

Sara Lorimer: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; writing – original draft; writing – review and editing. **Teresa McCormack:** Conceptualization; funding acquisition; investigation; methodology; writing – review and editing. **Christoph**

Hoerl: Conceptualization; funding acquisition; methodology; writing – review and editing. **Matthew Johnston:** Conceptualization; methodology; writing – review and editing. **Sarah R. Beck:** Conceptualization; funding acquisition; methodology; writing – review and editing. **Aidan Feeney:** Conceptualization; funding acquisition; methodology; project administration; supervision; writing – original draft; writing – review and editing.

FUNDING INFORMATION

This research was funded by Grant RPG-2018-019 from the Leverhulme Trust.

CONFLICT OF INTEREST STATEMENT

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

DATA AVAILABILITY STATEMENT

Research materials, data, and code are available at the following link: <https://osf.io/a8peb/>. The study and analyses were not preregistered.

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How to cite this article: Lorimer, S., McCormack, T., Hoerl, C., Johnston, M., Beck, S. R., & Feeney, A. (2023). Do both anticipated relief and anticipated regret predict decisions about influenza vaccination? *British Journal of Health Psychology*, *00*, 1–15. <https://doi.org/10.1111/bjhp.12691>