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Do emotional carryover effects carry over?

Nikhil Masters[1], Tim Lloyd[2] and Chris Starmer[3]

September 2022

Abstract

Existing research has demonstrated carryover effects whereby emotions generated in one context influence decisions in other, unrelated ones. We examine the carryover effect in relation to valuations of risky and ambiguous lotteries with a novel focus on comparing the carryovers arising from a targeted stimulus (designed to elicit a specific emotion) with those arising from a naturalistic stimulus (expected to produce a more complex emotional response). We find carryover effects using both a standard targeted stimulus and a naturalistic one, but they are stronger for the naturalistic stimulus and in the context of ambiguity. These effects are also highly gender-specific with only males being susceptible. To probe the emotional foundations of behaviour, we conduct analysis relating individual self-reports of emotions to incentivised valuation behaviour. Our results cast doubt on the interpretation of some evidence purporting to establish links between specific incidental emotions and risk taking.

Keywords Incidental emotions · Emotional carryover · Risk · Ambiguity · Naturalistic · Structural equation modelling

JEL classification C91 · D81 · D91

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1 Introduction

This paper examines the role of *incidental* emotions which arise from one context but "carryover" to influence behaviour in a different, seemingly unrelated, context. Specifically, we report an experiment designed to compare the impact of different emotional priming tasks on individuals' subsequent decisions involving risk and ambiguity. The key novelty of our approach lies in comparing the effects of a standard prime, designed to elicit a single targeted emotion (fear) with the effects of a more *naturalistic* prime, taken from a real event, that we expect to generate a broader spectrum of emotional responses.

A literature dating back four decades has found strong evidence of carryover effects in settings characterised by risk.[1] This includes the seminal work of Johnson and Tversky (1983) who identified the influence of incidental mood on risk perceptions; a substantial literature in experimental psychology (e.g., Isen and Patrick 1983; Nygren 1998; Raghunathan and Pham 1999; Bruyneel et al. 2009); and more recent work by economists (e.g., Drichoutis and Nayga 2013; Stanton et al. 2014; Treffers et al. 2016; van Well et al. 2019). A feature of the more contemporary work generated in economics labs is that it has tended to focus on carryover effects on financially incentivised risky choice, as opposed to self-reported risk perceptions or hypothetical risky decisions. This later work has also suggested more nuanced patterns in the carryover effect. These include gender differences (Fessler et al. 2004; Fehr-Duda et al. 2011; Conte et al. 2018) and sensitivity to different types of uncertainty, such as strategic risk and ambiguity (Kugler et al. 2010; Baillon et al. 2016).

One of our primary contributions is to examine carryover effects associated with a novel 'naturalistic' emotional stimulus as compared to a more conventional emotional prime. In the existing literature, the typical approach has been to use stimuli (such as fictional film clips) designed to target specific individual emotional responses such as fear. While it has been established that they can reliably generate fear responses (see Gross and Levenson 1995; Hewig et al. 2005, Rottenberg et al. 2007; Gabert-Quillen et al. 2015) and that subjects who have been primed this way sometimes exhibit

[1] Experimental studies have also found evidence for the effect of incidental emotions on other economic behaviours. These include spending and the willingness-to-pay gap (Lerner et al. 2004; Cryder et al. 2008), time preferences (Ifcher and Zarghamee 2011), social preferences (Kirchsteiger et al. 2006; Andrade and Ariely 2009; Drouvelis and Grosskopf 2016) and trading in financial markets (Lee and Andrade 2011, 2015; Andrade et al. 2016).

carryover effects, questions have been raised about the representativeness of such stimuli. Specifically, doubts about their generalisability are based on two distinct concerns. The first concern is in line with arguments dating back to Frijda (1989) who suggested that emotions generated from simulated experiences such as fiction may be qualitatively different (e.g., more 'aesthetic' in nature) than those generated in real life. Such considerations suggest a *prima facie* doubt over whether carryover effects associated with conventional fictional stimuli are good indications of carryover effects that would be associated with more naturalistic stimuli. A second concern is that emotional responses to natural events will usually be more *complex* than those generated in experiments targeting a single emotion. For example, consider an individual's reaction to learning of a recent nearby terrorist event. It seems plausible that such knowledge might provoke a range of emotions including fear, anger, sadness, disgust and so on. Moreover, it seems possible that more complex emotional responses might have more or less potential to carryover: for example, emotions may cancel each other out, thereby reducing the overall propensity to carryover; alternatively, similar emotions might reinforce one another, creating stronger carryover effects. To date, there is no evidence exploring carryover effects to risky decision making in contexts likely to create more complex emotional responses. Our research breaks new ground by investigating this issue via the use of a naturalistic priming task.

This paper also relates to a literature employing stimuli from real events to examine risk perceptions, for example, in the contexts of terrorism (Lerner et al. 2003; Fischhoff et al. 2005), natural disasters (Västfjäll et al. 2008) and food safety (Sinaceur et al. 2005). A common finding amongst these studies is that stimuli related to real events can often has an impact on risk perceptions in other domains. Part of our contribution is to investigate related processes but with a focus on carryover effects to incentivised decisions in a controlled laboratory setting.

A further contribution of our paper is to explore the microfoundations of associations between emotional responses (as captured by self-reports) and decision behaviour. In the study of carryover effects arising from specific emotions (e.g., examining the impact of fear on risk taking), a common approach has been to compare the behaviour of two groups of subjects who have been exposed to different emotional primes, for example, by looking at the willingness of subjects to take risks following either neutral or fear primes. Multiple studies then draw the conclusion that 'fear affects risk taking' from the conjunction of observing both higher reports of fear and different willingness to take risks in the group that received the fear prime. While such findings – usually based on group-level comparisons of average responses – are interesting in their own right, they provide a limited window on the underlying connections between specific emotions and behaviour. For example, it is possible that other non-targeted and thus, unmeasured emotions (or sets of emotions) could be driving behaviour. Our study probes more deeply into these issues by measuring a wider range of emotional responses and by relating them to individual-level decisions through structural equation modelling. As such, our paper contributes directly to a relatively small contemporary literature investigating links between individual-level emotions and risky decision making (see for example, Bosman and Van Winden 2010; Nguyen and Noussair 2014; Cohn et al. 2015) with a novel focus on emotional carryovers comparing targeted and naturalistic stimuli in both risky and ambiguous settings.

Our main findings are as follows. We observe significant carryover effects and they are stronger for the naturalistic (compared to the targeted) stimulus and stronger for decision making under ambiguity (compared to risk). The effects are also gender-specific with carryover effects for both the targeted and naturalistic prime occurring only for males. We find mixed support for an emotional basis of the carryover effect. For the targeted case, although we identify an emotional mechanism driving behaviour, this is not connected to the emotion that the related prime is usually interpreted as targeting (i.e., fear). For the naturalistic case, although we observe a strong carryover effect, we are unable to find any reliable link between emotional responses and the carryover effect, raising doubt about its interpretation as an emotional carryover effect. The remainder of the paper is organised as follows. Section 2 outlines the experimental design. Section 3 reports the results of the experiment and the individual-level analysis. Section 4 discusses the broader implications of our results and concludes.

2 Experimental design

The main elements of the experimental design are summarised in Figure 1. Subjects were randomly allocated to one of three treatments – *control*, *targeted* and *naturalistic*. In each treatment, subjects undertook one of three emotional priming tasks, each designed to produce a distinct profile of emotional responses. We elaborate on the expected emotional profiles and the emotional priming procedures for each treatment in Section 2.1. Following the priming task, we measured subjects' valuations for both a risky and an ambiguous lottery (details in Section 2.3). We test for carryover effects by looking for treatment differences in the average measured valuations. Self-reported emotions were measured twice for each subject in pre-and post-experimental questionnaires (details in Section 2.2). General experimental procedures are explained in Section 2.4.

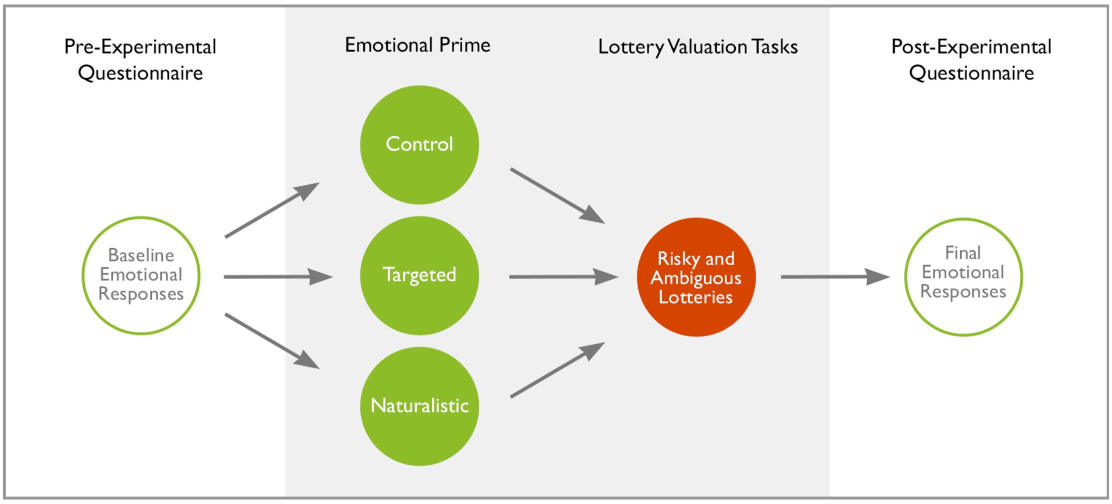


Fig. 1 Experimental design

2.1 Emotional priming task

Two of the three emotional primes used in our experiment are designed to replicate classic primes used in previous literature: a neutral prime in our control treatment and a prime designed to induce a specific emotion, fear, in our targeted treatment. A key novelty of our design is the use of a naturalistic prime (in the naturalistic treatment), which we expect to produce a more complex emotional response relative to the targeted prime. In each of the three treatments, subjects were primed by watching a short video clip followed by a self-reflective writing task designed to make the emotional experiences more personally meaningful.[2] This procedure is based on standard protocols for inducing emotional states (examples include Lerner et al. 2004; Cryder et al. 2008; Andrade and Ariely 2009).[3]

In the control treatment, subjects watched a video clip from a National Geographic Special about the Great Barrier Reef. This has been widely used in carryover experiments as a control prime (Lerner et al. 2004; Gino and Schweitzer 2008; Han et

[2] Full details regarding the video stimuli used in the experiment are given in the electronic supplementary material (online resource 1).

[3] For a comprehensive comparison of affective priming procedures see Westermann et al. (1996).

al. 2012). In the writing task, subjects were asked for opinions about the suitability of the clip as a wildlife documentary.

Our targeted stimulus is based on that identified by Gross and Levenson (1995) as a successful prime to induce fear. We chose fear as the targeted emotion because this has received much attention in the literature as an emotion that affects risky choice (Kugler et al. 2010; Lee and Andrade 2011, 2015; Cohn et al. 2015; Yang et al. 2020). Subjects watched a video clip from the film "The Shining". The clip depicts a boy looking for his mother in an empty corridor whilst tense music plays in the background. Gross and Levenson (1995) found that this stimulus generates a fear response that is both strong and clean (in the sense that no other negative emotions are induced).[4] In the writing task, subjects were asked about how they would feel if they were the person depicted in the video clip.

For the naturalistic treatment we used a video stimulus constructed from UK documentary and news reporting of real events connected to the 'BSE crisis' – a serious food safety issue prominent in the 1990s, following the discovery of apparent links between human consumption of beef infected with Bovine Spongiform Encephalopathy (BSE) and the rare but fatal degenerative disease CJD (human variant of Creutzfeldt-Jacob disease). In the writing task, subjects were asked how they felt about the risk of contracting a disease similar to what was depicted in the video clip.

The control and targeted primes were selected as classic 'off the shelf' neutral and fear primes and our interest in them is partly as benchmarks: in relation to emotional responses, based on past literature, we expect to find relatively mild emotional responses for the control prime and, in the targeted treatment, we expect to find a fear response and few, if any other significant negative emotions. By contrast, for the naturalistic prime, we sought a stimulus which would generate strong, but diverse emotions. To this end, we selected the BSE crisis as a good candidate in being both highly emotive and likely to produce a relatively complex spectrum of emotional responses. Food anxieties have long threatened consumers giving rise to food scares (see Beardsworth and Keil 1997). The BSE scare produced a dramatic consumer reaction with beef sales falling by 40% immediately after the announcement, a ban imposed on UK beef products and an estimated total economic loss of up to £980

[4] If you know this classic film scene, reader, we predict that the hairs on your spine are currently tingling as you bring the scene to mind.

million (DTZ Pieda Consulting 1998). The media coverage was extensive with sustained focus on a number of highly emotive issues including: fear about potential health risks, sadness associated with the consequences of contracting the disease, disgust from the visceral images of infected cows and food contamination; and anger against the beef industry and its oversight. For our experiment, we constructed a video stimulus using a selection of actual news reports from the time. We note that by using an event that was not prominent in the current news at the time of running the experiment, we sought to ensure that the BSE issue was only salient to those subjects in the naturalistic treatment.

2.2 Emotional responses and the circumplex representation

Relative to priming studies which have focused on a specific and usually very limited range of emotions, our objectives require us to assess a potentially broad spectrum of emotions which might be generated by our naturalistic stimulus. Hence, we need some framework for determining both *which emotions to measure* as well as *how to measure them*. We address these issues in turn here.

We organise our selection of emotions to measure with reference to the so-called Circumplex Model of Affect (Russell 1980; Larsen and Diener 1992). The Circumplex Model provides a visual representation of affective space, in which emotions are placed into octants arranged on a circle along two dimensions: pleasantness and activation.[5] One guiding principle for choosing our set of emotions is that we wanted some representation in all octants. Also, given our expectation that the targeted and naturalistic primes would produce differing emotional profiles in the negative affective space, we chose to over-represent the 'unpleasant' octants with negative emotions including sadness, disgust, fear and anger. Taking emotions from the circumplex literature as well as including some additional items specifically for this study, our circumplex is presented in Figure 2. Here, the circumplex octants are labelled in the outer ring, whilst corresponding emotions are shown in the inner circle. The octant 'activated unpleasant' is broken down into the emotional sub-groups: disgust, anger and fear (D, F, A - associated emotions in the key), which for the purpose of our analysis we treat as separate emotional groups. We therefore have a total of 10 emotional groups for the subsequent analysis.

[5] This labelling of the dimensions is based on the version from Larsen and Diener (1992).

As well as providing structure for the selection of emotions in our study, the circumplex framework also informs our analysis. At the treatment level, we use the circumplex to visualise emotional profiles and test emotional activation (see Section 3.1). At the individual level, we use the 10 emotional groups as variables to probe the emotional basis of decisions (see Section 3.3).

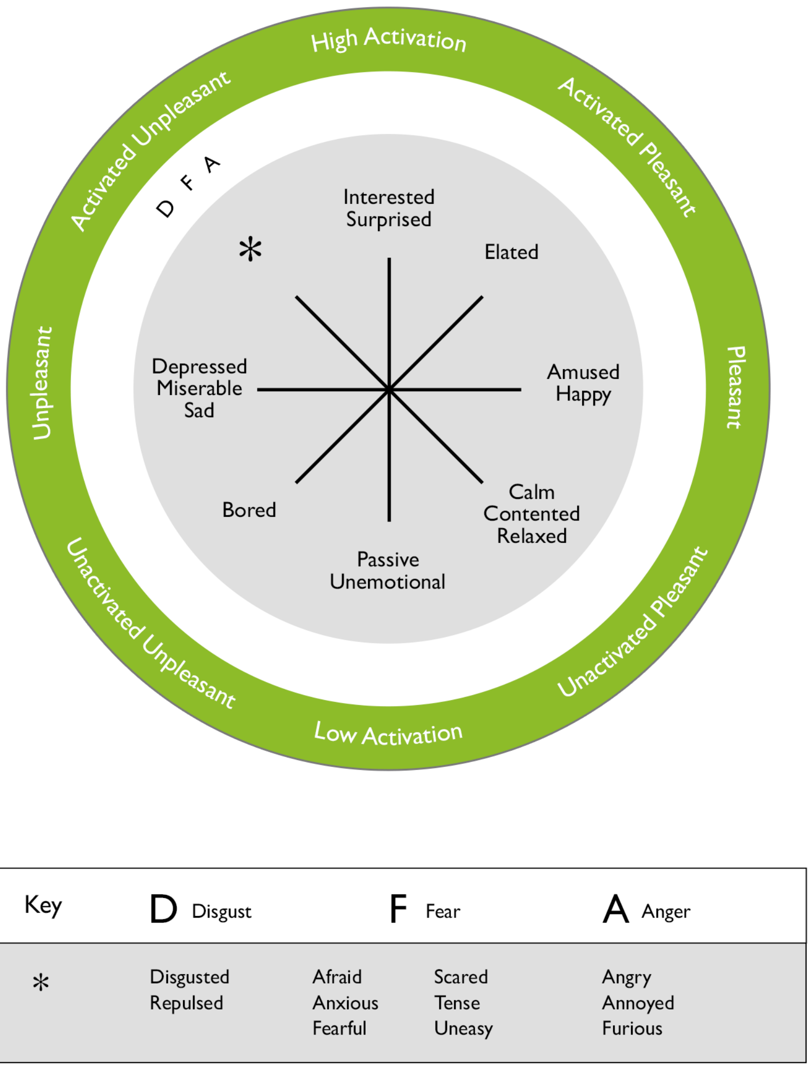


Fig. 2 Circumplex model of affect

We measured emotions using self-reports which is a standard approach in the literature (see Robinson and Clore 2002). However, departing from the convention of measuring emotions only once, we took measures of emotions twice recording baseline and final emotional responses for each subject.[6] To measure baseline responses, subjects were presented with the set of emotions and asked to indicate on a scale to what extent they had a particular feeling at that moment. Consistent with other studies, we used a response scale that ranged from 0 (do not have this feeling at all) to 8 (have this feeling more than ever before). To measure final responses, subjects were given the same emotions and scale and asked to indicate the extent to which the video clip and writing task had prompted each of these feelings.[7] We then calculated the within-subject difference between the two measures for each emotion. A positive difference indicates an increase relative to the baseline, whilst a negative difference indicates a decrease relative to the baseline. Via this strategy, we measure changes in emotions attributable to responses to our treatment manipulations, across the full affective space of the circumplex model.

2.3 Lottery valuation tasks

The existence of carryover effects is tested by comparing valuations of risky and ambiguous lotteries in the targeted and naturalistic treatments relative to corresponding valuations in the control treatment. Following the emotional prime, all subjects undertook two lottery valuation tasks, one for a risky lottery and the other an ambiguous lottery. For the risky task, the lottery gave a 50% probability of winning £12 or nothing. For the ambiguous task, the lottery gave an unknown probability of winning £12 or nothing. We used physical devices to operationalise these lotteries in order to make differences between the risky and ambiguous tasks salient and easy to understand. For the risky lottery, subjects drew a disc out of a bag, which contained 10 blue and 10 red discs. Subjects were shown the discs being placed into the bag beforehand and verified the composition of the discs. For the ambiguous lottery, subjects did not see the discs

[6] In addition to the 25 emotions within the circumplex framework, following the literature on priming using film we also asked subjects to indicate the extent to which they felt confused (as a measure of general understanding of the video stimuli) as well as some emotionally neutral terms: neutral and indifferent.

[7] Final emotional responses were measured after the lottery valuation tasks as it has been shown that labelling one's feelings after an emotional prime reduces its effect on the variable of interest (Schwarz and Clore 1983; Keltner et al. 1993; Yip and Côté 2013).

being placed into the bag: they knew that the bag contained a mix of blue and red discs but not their relative proportions. In each experimental session, the order of the two lottery valuation tasks was randomised.

We elicited certainty equivalent (CE) valuations for these lotteries using a simple price list design. For each task, subjects were presented with a decision sheet containing 25 rows, as shown in Figure 3. In each row, subjects chose whether they preferred to play the lottery (option A) or take a certain amount of money for sure (option B). These certain amounts of money increased moving down the rows and were set so that most individuals prefer the lottery in the top row, but prefer the certain amount by the bottom row. Hence, we expected each subject to switch from A to B as they moved down the table and we interpret the switch point as revealing the lower-bound of an interval capturing the subject's certainty equivalent of the lottery. For the risky task, this valuation can be further interpreted as reflecting an individual's risk attitude.[8] Risk neutral subjects will switch at the expected value of the lottery, which is £6.00. Switching before this point indicates risk-averse behaviour, whilst switching after indicates risk-seeking behaviour. For the ambiguous task, the switch point also reflects any attitudes towards uncertainty.[9] If, as is plausible, experimental subjects are averse to the source of ambiguity in our setup, then we may expect average valuations for the ambiguous lottery to be lower than those for the risky lottery within a given treatment.

Subjects' decisions in the two valuation tasks were motivated with financial incentives: subjects knew in advance that the experimenter would select one row at random from either decision sheet to be rewarded for real according to the subjects' decisions (see Bardsley et al. 2010, ch.6, for discussion and defence of such standard random incentive procedures).

[8] Consider, for example, an expected utility model in which a single parameter, α, controls curvature of the utility function. An individual's switch point can then be used to impute bounds on their α.

[9] Various models of ambiguity attitudes provide alternative interpretations of ambiguity sensitive preferences. We do not rely on any specific theoretical model, but for discussions of alternative models see Wakker (2010), Etner et al. (2012) and Gilboa and Marinacci (2013).

1	Play Option A	○	Receive £3.00 for sure	○
2	Play Option A	○	Receive £3.25 for sure	○
3	Play Option A	○	Receive £3.50 for sure	○
4	Play Option A	○	Receive £3.75 for sure	○
5	Play Option A	○	Receive £4.00 for sure	○
6	Play Option A	○	Receive £4.25 for sure	○
7	Play Option A	○	Receive £4.50 for sure	○
8	Play Option A	○	Receive £4.75 for sure	○
9	Play Option A	○	Receive £5.00 for sure	○
10	Play Option A	○	Receive £5.25 for sure	○
11	Play Option A	○	Receive £5.50 for sure	○
12	Play Option A	○	Receive £5.75 for sure	○
13	Play Option A	○	Receive £6.00 for sure	○
14	Play Option A	○	Receive £6.25 for sure	○
15	Play Option A	○	Receive £6.50 for sure	○
16	Play Option A	○	Receive £6.75 for sure	○
17	Play Option A	○	Receive £7.00 for sure	○
18	Play Option A	○	Receive £7.25 for sure	○
19	Play Option A	○	Receive £7.50 for sure	○
20	Play Option A	○	Receive £7.75 for sure	○
21	Play Option A	○	Receive £8.00 for sure	○
22	Play Option A	○	Receive £8.25 for sure	○
23	Play Option A	○	Receive £8.50 for sure	○
24	Play Option A	○	Receive £8.75 for sure	○
25	Play Option A	○	Receive £9.00 for sure	○

Fig. 3 Decision sheet for lottery valuation tasks

2.4 Experimental procedures

186 student subjects (100 female, 86 male) from the University of Nottingham took part in the experiment. Subjects were recruited using ORSEE (Greiner 2015). Upon entering the laboratory, subjects were seated in private booths equipped with computers and headphones with no visual access to other participants. Subjects first completed the pre-experimental questionnaire to measure their baseline emotional responses. In order to minimise experimenter demand, the emotional prime and lottery valuation tasks were framed as two studies.[10] Before watching their video clip, subjects were asked to sit back, relax and take a couple of deep breaths to help them focus fully on the stimulus. The main lights were turned off and the subjects were prompted to start the video clip.[11] After completing the valuation tasks, subjects completed the post-experimental

[10] The two tasks were referred to as the "video study" and the "decision-making study" respectively. Subjects received a fixed payment for the video study conditional on completion of the writing task. All paper materials for the video study were collected in before subjects undertook the lottery valuation tasks. Full transcripts of the experimental instructions and materials are given in the electronic supplementary material (online resource 2).

[11] The video clips were played using z-Tree (Fischbacher 2007). All subjects saw identical screens and the video clips played at the same time.

questionnaire which measured the final emotional responses and demographic information. Each session took approximately 1 hour to complete, including instructions and payment and subjects earned on average £9.48.

3 Results

We structure the results in the following way. In Section 3.1, we present the emotional profiles for our three treatments. In Section 3.2, we test for carryover effects by comparing valuations of the risky and ambiguous lotteries across treatments. In Section 3.3, we examine relationships between emotional responses and valuations.

3.1 Emotional profiles across treatments

Examining emotional profiles serves two key purposes. First, we can check whether our implementation of the off-the-shelf priming tasks (control and targeted treatments) produce the patterns expected, based on the extant literature. Second, we can check whether our novel naturalistic prime produces, as we conjectured, a broader spectrum of emotional responses. Both can be considered as manipulation checks, but the second is particularly important given our research objectives.

Figure 4 visualises the emotional profiles on the circumplex diagram. For each treatment, the spokes radiating from the centre are used as axes to locate data for each emotional group. Each circle represents the mean difference (MD) between the first and second measurement of the individual emotions for that group, averaged across subjects, for a particular treatment. The diameter of each circle is an indication of the relevant effect size.[12] A dark circle indicates an increase in the mean reported emotion for a group; a light circle indicates a decrease. Since we have separate observations for disgust, fear and anger, these lie on/close to the activated unpleasant axis and are labelled D, F, A respectively. We test whether the mean of each emotional group significantly increased or decreased within a particular treatment using a paired t-test. The distance from the origin denotes the t-ratio with the dotted circles representing thresholds of significance at the 5% and 1% levels (the 1% threshold being the one further out from the centre).

[12] This is operationalised in the figure by constructing the size of each circle as a percentage of the largest data point in the dataset.

Looking first at the emotional profile for the control treatment (left-hand panel of Figure 4), we see that, as expected, the stimulus generated only mild emotional responses, compared with the other two treatments. A significant increase (5% level) is found for just one emotional group, high activation (MD=0.518, p<0.05). Note that this is mirrored by a significant decrease in low activation (MD=-0.616, p<0.01). A similar pattern of increases in high activation and decreases in low activation is observed for all three treatments; a finding which we interpret as evidence that subjects were engaged in the experiment. Significant decreases are found amongst the unpleasant emotional groups, though the effect sizes are small compared to the other two treatments (unpleasant: MD=-0.524, p<0.01; disgust: MD=-0.232, p<0.05; fear: MD=-0.557, p<0.05; anger: MD=-0.512, p<0.01). The mild emotional responses observed in this treatment enable us to use the risk behaviour observed in this treatment as a control when we test for carryover effects (see next section).

Turning to the emotional profile for the targeted treatment (middle panel of Figure 4), we are able to replicate the findings of Gross and Levenson (1995) that this stimulus provides a strong and clean fear response, at least insofar as we focus on the negative emotions located in the north-west quadrant of the circumplex. Increases in fear are the largest of all emotion groups in all treatments (MD=2.189, p<0.000), whereas effect sizes for other unpleasant emotions are low and insignificantly different from zero (unpleasant: MD=-0.055, p=0.7242; disgust: MD=0.159, p=0.06; anger: MD=-0.030, p=0.7811). That said, large and significant decreases are found amongst the pleasant groups. In particular, we observe a very large reduction for unactivated pleasant, similar in magnitude to the change in fear but with the opposite sign (MD=-2.048, p<0.000). We also find significant but smaller reductions for activated pleasant (MD=-0.871, p<0.001) and pleasant (MD=-1.136, p<0.000). Since this emotional prime produces a strong fear response, we will use it to retest existing claims (see next subsection) that incidental fear influences risk attitudes.

The fact that our implementation of two standard priming tasks both produce the expected emotional profiles in line with existing evidence, provides some reassurance that our priming procedure and measurement of emotions has some degree of internal validity. Against this backdrop we now consider the emotional profile for subjects exposed to our novel prime.

Examining the emotional profile of the naturalistic treatment (right-hand panel of Figure 4), we find marked differences compared to the targeted treatment. Specifically, as hypothesised, this stimulus generates multiple emotional responses of differing intensities within the unpleasant dimension of the circumplex. Significant increases are observed for unpleasant (MD=0.790, $p<0.001$), disgust (MD=1.153, $p<0.000$), fear (MD=0.956, $p<0.000$), although not anger (MD=0.086, $p=0.715$). Similar to the targeted stimulus, however, we observe significant decreases in the pleasant groups (pleasant: MD=-1.242, $p<0.000$; unactivated pleasant: MD=-1.630, $p<0.000$). In line with our expectations, this emotional prime, based on reporting of real events, produces an emotional profile in which multiple emotions have been triggered. Hence, as we hoped, we are in a position to assess the impact of a prime generating a more complex emotional response.

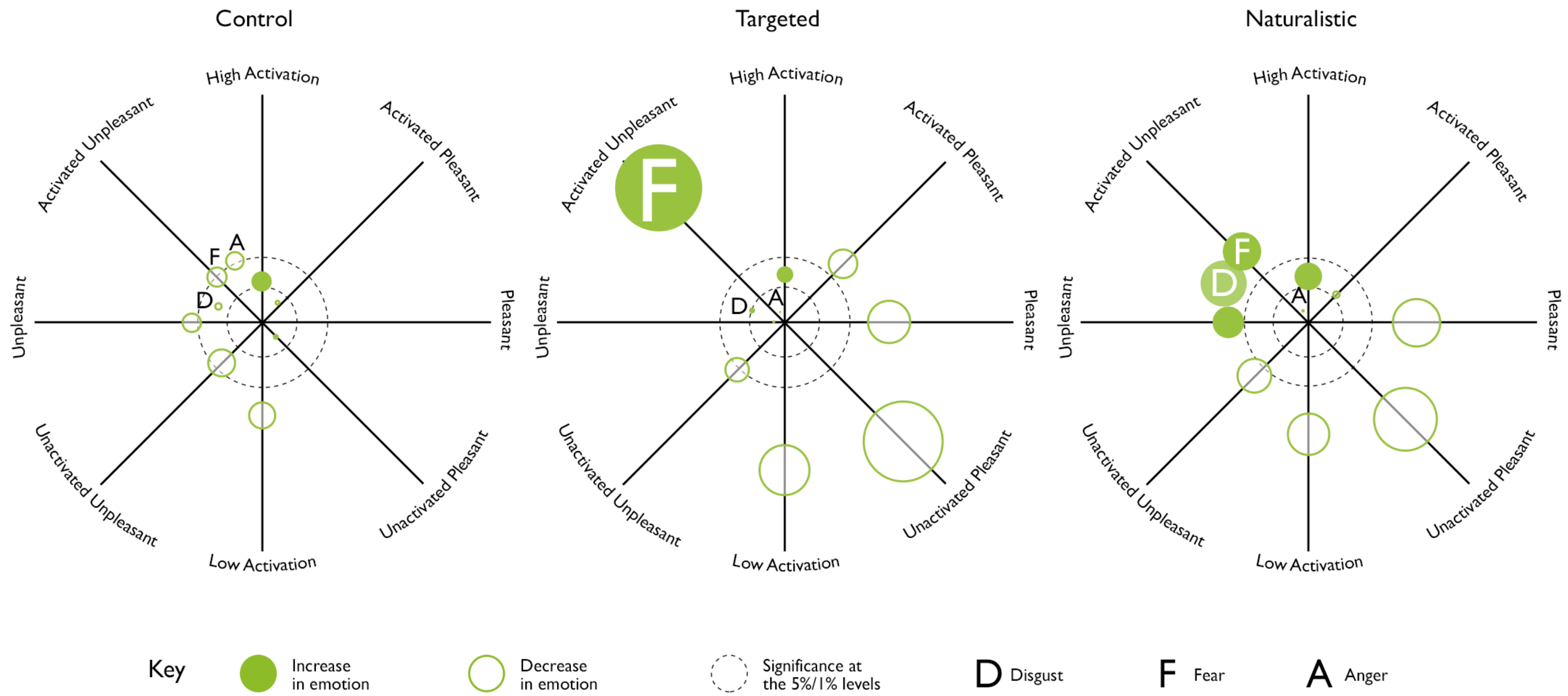


Fig. 4 Emotional profiles across treatment

3.2 Carryover effects on lottery valuations

In this section, we test for carryover effects by comparing mean valuations of the risky and ambiguous lotteries in the targeted and naturalistic treatments relative to valuations in the control. Treatment differences (d) are tested using a two-sample t-test and are reported in monetary units.[13]

Mean lottery valuations across treatment and gender are summarised in Figure 5. Focusing first on risky valuations in the left-hand panel, the most striking feature is that we see clear treatment effects but they are gender specific: for males, compared to the control, risky valuations are lower in the targeted treatment (d=-0.493, p=0.179) and even lower in the naturalistic treatment (d=-0.907, p<0.05). Female behaviour, on the other hand, does not exhibit this pattern: risky valuations are not significantly different from the control in both the targeted (d=0.036, p=0.897) and naturalistic treatments (d=-0.102, p=0.770). This leads to the statement of a primary result – *we observe carryover effects on risky decision making and these effects are stronger for the naturalistic stimulus, but only males are susceptible.*

Turning now to ambiguous valuations in the right-hand panel of Figure 5, we observe a similar pattern. Compared to the control, male ambiguous valuations are significantly lower in the targeted treatment (d=-0.755, p<0.05) and are again even lower in the naturalistic treatment (d=-1.182, p<0.01). However, female ambiguous valuations are similar across all treatments and we do not see any carryover effects for them (targeted: d=-0.304, p=0.373; naturalistic: d=-0.112, p=0.756). This gives us another key result – *for males, carryover effects on ambiguous decision making follow a similar pattern to those for risky decisions, but the treatment differences are even stronger.*

Although in the control treatment we replicate the standard finding that males are more risk-seeking than females (d=0.904, p<0.05), these gender differences diminish when female valuations in the control are compared to male valuations in the other treatments. Gender differences are insignificant when compared to male valuations in the targeted treatment (d=0.412, p=0.21). Furthermore, female valuations in the control

[13] Before proceeding with the analysis, we excluded lottery valuation data from subjects who indicated multiple switching on the decision sheet between the lottery and sure amount. For risky valuations, 19 out of 186 observations were dropped. For ambiguous valuations, 20 out of 186 were dropped.

and male valuations in the naturalistic treatment are indistinguishable (d=-0.003, p=0.994). This pattern is also observed with ambiguous valuations. Ambiguous valuations are higher for males compared to females in the control treatment (d=1.094, p<0.05), but these gender differences disappear when we compare male valuations in the other treatments to female valuations in the control (targeted: d=0.340, p=0.294; naturalistic: d=-0.088, p=0.808). The carryover effect therefore eradicates gender differences in risky and ambiguous decisions commonly observed in individual choice experiments.

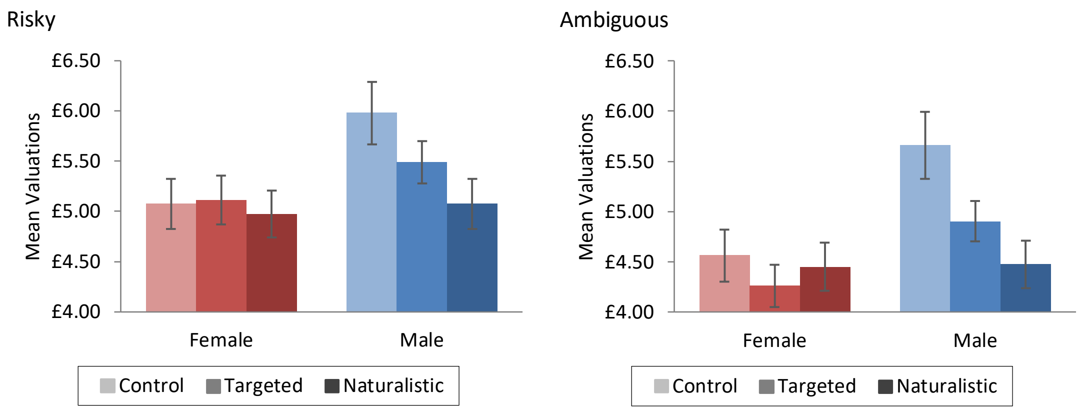


Fig. 5 Mean lottery valuations. Error bars indicate mean ± standard error

As a robustness check, we pool the data across treatments and run OLS regressions to assess the impact of treatments on valuations. We estimate separate models for risky and ambiguous lotteries and, in each case, we run versions with and without a set of additional controls. Model 1 contains the experimental treatment variables (targeted and naturalistic), treatment-gender interactions and task ordering (ambiguous→risky=1). Model 2 incorporates additional demographic control variables from the post-experimental questionnaire.[14]

The regression analysis presented in Table 1 shows a consistently significant negative effect of the naturalistic treatment. The size of the effect means that subjects in the naturalistic treatment, on average, switch between 4 to 6 rows earlier in the price list table consistent with an average reduction in valuation of the order of £1.00 – £1.50

[14] One subject did not fully complete the post-experimental questionnaire leading to one less observation in the regression models that include additional controls. A full list of the controls used in these models is given in the Appendix, Table 4.

(recall that the expected value of the risky lottery is £6). The effects are larger and more strongly significant for the case of the ambiguous lottery and the effects become slightly larger when additional controls are added. The regressions confirm an interaction between gender and treatment, though only significant for the ambiguous lottery. Notice that the interaction effect (Naturalistic x Female) in the last two columns is similar in size to the treatment effect of Naturalistic but with the opposite sign – indicating that the treatment effect occurs only for males. We also identify an effect of reduced risk taking in the targeted treatment, but this effect is only significant in the ambiguity case. Overall, these results confirm a main finding of our analysis: relative to the control treatment, the naturalistic prime has a stronger and more consistent impact on behaviour than the targeted prime, although these carryover effects are gender-specific with only males being susceptible.

Table 1 OLS regression models for risky and ambiguous valuations

	Risky		**Ambiguous**	
Dependent variable: Lottery valuations	Model 1	Model 2	Model 1	Model 2
Targeted	-0.548	-0.406	-0.831**	-0.743**
	(0.350)	(0.346)	(0.352)	(0.341)
Naturalistic	-1.012**	-1.028**	-1.298***	-1.449***
	(0.397)	(0.422)	(0.389)	(0.409)
Targeted X Female	0.676	0.837*	0.657	0.943
	(0.508)	(0.501)	(0.509)	(0.497)
Naturalistic X Female	0.970	0.854	1.245**	1.218**
	(0.520)	(0.527)	(0.509)	(0.504)
Female	-0.983***	-1.031***	-1.207***	-1.267***
	(0.371)	(0.377)	(0.371)	(0.372)
Task Order	0.404**	0.445**	0.511**	0.548***
	(0.206)	(0.206)	(0.203)	(0.200)
Constant	5.803***	5.605***	5.450***	5.341***
	(0.285)	(0.293)	(0.285)	(0.288)
Controls	No	Yes	No	Yes
Adj. R-Squared	0.051	0.097	0.102	0.175
Observations	167	166	166	165

Standard errors are in parentheses. *p<0.10, **p<0.05, ***p<0.01.

3.3 Testing the emotional foundations of the carryover effect

Having observed carryover effects, we now examine whether the emotional responses generated from the emotional stimuli can explain the differences in lottery valuations across treatments and gender.

The proposed model linking emotions to valuations is shown as a path diagram in Figure 6. The observed treatment effect is denoted by path *c*. The model decomposes this treatment effect into (i) an indirect effect (emotional) via paths marked *a* and *b*; (ii) a direct effect (non-emotional) indicated by paths marked *c'*. Path *a* indicates how much a specific emotion responds to a treatment (targeted or naturalistic) relative to the control; and path *b* indicates the impact of that emotion on a given type of valuation (risky or ambiguous). Separate paths are constructed for males and females, denoted with subscripts *M* and *F*, respectively.

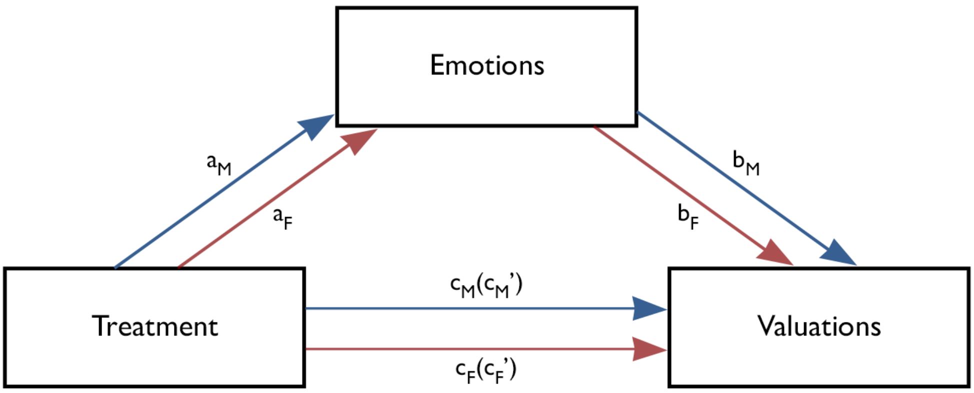


Fig. 6 Path diagram linking emotions and lottery valuations

Since we are interested in the behavioural effects of emotions across the whole emotional space, we operationalise the 'emotions' part of the model using the emotional groups from the circumplex. Specifically, for each subject, we use the mean difference between the first and second measurement across the set of emotions for a given group, forming 10 individual-level emotion variables for the analysis. For given pairs of treatments (see below), we then estimate paths *a* and *b* for each emotion individually, conditional on the effect of the other emotions in the model. To formally test the impact of each emotion in explaining treatment effects, we test the significance of the product of coefficients (POC) of path *a* and path *b* for that emotion. We also examine treatment effect sizes after the inclusion of emotions into the model (by comparing the coeffcients of the observed treatment effect with those of the direct effect). One advantage of our testing strategy is that we allow for the possibility of multiple emotions having an impact on individual valuations.[15] As a consequence of this, it is possible that the effect of one emotion could be offset by other emotions and/or the direct effect, leaving the treatment effect insignificant i.e., an emotion may still be identified as a determinant of valuations even when no treatment effects were observed in the experiment.[16] For this reason, we do not limit our analysis to where we find significant treatment effects but examine the effect of emotions in all treatments, for males and females.

As we saw in the emotional profiles of the targeted/naturalistic treatments in Section 3.1, circumplex groups which increased were often counterbalanced with reductions in the polar opposite group within the circle. Although this negative correlation is not surprising, including the full set of variables in a single estimated model would create severe collinearity problems. In order to mitigate this, we split the analysis into two separate models: An 'increases' model includes emotions if they increased in the targeted/naturalistic treatments; and a 'decreases' model includes emotions if they decreased in these treatments.

We estimate these models separately for targeted vs control and naturalistic vs control, with each of these estimated separately for risky and ambiguous valuations, giving eight distinct models in all. Each model is estimated using structural equation modelling (SEM) methods, in which coefficients representing the paths in Figure 6 are estimated simultaneously. The system of regression equations for each model is given below. Equation (1) estimates the treatment effect (path c). Equations (2.1) – (2.k) estimate path a of the indirect effect for each emotion $1...k$ associated with each treatment. Equation (3) estimates path b of the indirect effect for each emotion and the direct effect (path c'). All paths include gender interactions to examine whether any emotional effects on valuations are gender-specific.

[15] Our approach is similar to the multiple mediation framework put forward by Preacher and Hayes (2008) and Fairchild and MacKinnon (2009).

[16] See MacKinnon et al. (2000) and Preacher and Hayes (2008) for further discussion on this.

$$V_i = c_0 + c_1 Treat_i + c_2 Treat_i \cdot Fem_i + c_3 Fem_i + c_4 Order_i + \varepsilon_{i1} \quad (1)$$

$$\Delta Emo_{i1} = a_{0,1} + a_{1,1} Treat_i + a_{2,1} Treat_i \cdot Fem_i + a_{3,1} Fem_i + \varepsilon_{i2,1} \quad (2.1)$$

$$\vdots$$

$$\Delta Emo_{ik} = a_{0,k} + a_{1,k} Treat_i + a_{2,k} Treat_i \cdot Fem_i + a_{3,k} Fem_i + \varepsilon_{i2,k} \quad (2.k)$$

$$V_i = b_0 + c_1^{'} Treat_i + c_2^{'} Treat_i \cdot Fem_i + c_3^{'} Fem_i + c_4^{'} Order_i + \sum_{j=1}^{k} b_{1,j} \Delta Emo_{ij} + \sum_{j=1}^{k} b_{2,j} \Delta Emo_{ij} \cdot Fem_i + \varepsilon_{i3} \quad (3)$$

In the above equations, V_i are valuations, $Treat_i$ is the experimental treatment, Fem_i is female, ΔEmo_{ij} is the within-subject difference of the j^{th} emotion $j = 1...k$, $Order_i$ is task order as defined previously, all for subject i.

The results from the SEM are presented below. Table 2 reports the *a* and *b* path coefficients for each emotion in models comparing the targeted treatment vs control for males. We observe similar patterns for both risky and ambiguous models and therefore report them together. Focusing first on the 'increases' model, the *a* path for fear is large, positive and highly significant, supporting the result that for males, the targeted treatment produces a clean fear response. Rather surprisingly however, the *b* path coefficient for fear is extremely small and not significantly different from zero for either risky or ambiguous valuations. This gives us a striking result – *the carryover effect observed for males in the targeted treatment is not explained by variation in fear. In fact, since none of the b paths in this model are significant, no emotion in the 'increases' model is able to explain the carryover effect.*

Turning to the 'decreases' model, we find significant *a* paths for pleasant emotions indicating that these emotions significantly decreased in the targeted treatment relative to the control. Furthermore, we find a significant, positive, *b* path for unactivated pleasant showing a relationship between this emotion and valuations. The POC coefficient is significant for risky valuations (POC=-0.550, p<0.05), and its size corresponds to 99% of the treatment effect. The POC coefficient for ambiguous valuations is also significant (POC=-0.527, p<0.05), and corresponds to 62% of the treatment effect. In short, we have found an emotional basis to the carryover effect in the targeted treatment, although the emotion driving this is a non-targeted emotion that decreased in the experiment.[17]

Table 2 SEM path coefficients: males – targeted vs control

	Risky		Ambiguous	
	a	b	a	b
Increases Model				
High Activation	0.078	0.006	0.078	-0.060
	(0.438)	(0.132)	(0.438)	(0.129)
Disgust	0.353*	-0.240	0.353*	-0.156
	(0.197)	(0.334)	(0.197)	(0.315)
Fear	1.960***	0.063	1.960***	0.088
	(0.453)	(0.100)	(0.453)	(0.097)
Anger	0.264	0.079	0.264	0.152
	(0.288)	(0.182)	(0.288)	(0.171)
Unpleasant	0.194	-0.128	0.194	-0.303
	(0.340)	(0.194)	(0.340)	(0.183)
Decreases Model				
Activated Pleasant	-0.640	-0.142	-0.640	-0.070
	(0.429)	(0.125)	(0.429)	(0.127)
Pleasant	-1.302***	-0.133	-1.302***	-0.095
	(0.427)	(0.103)	(0.427)	(0.101)
Unactivated Pleasant	-1.286***	0.415***	-1.286***	0.384***
	(0.445)	(0.130)	(0.445)	(0.130)
Low Activation	-0.716*	-0.107	-0.716*	-0.165*
	(0.395)	(0.129)	(0.395)	(0.130)
Unactivated Unpleasant	0.281	-0.252***	0.281	-0.142
	(0.560)	(0.095)	(0.560)	(0.097)

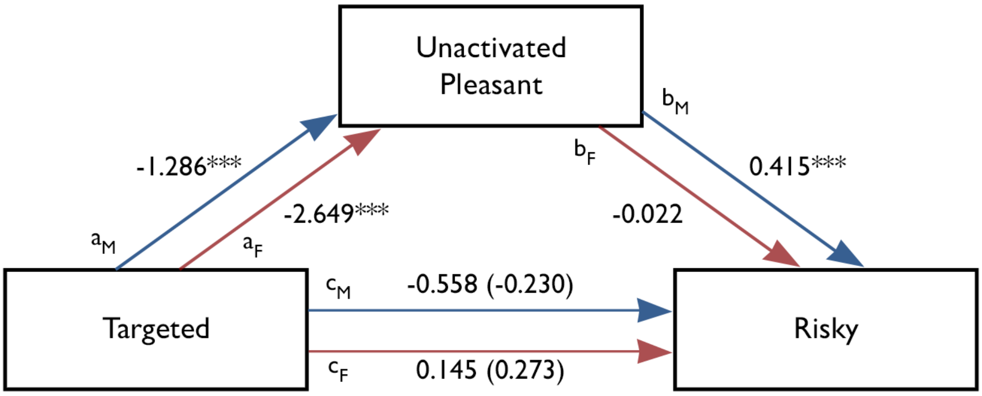
Standard errors are in parentheses. *p<0.10, **p<0.05, ***p<0.01

For a clearer view of this mechanism, we present a path diagram for the effect of unactivated pleasant on valuations including both male and female paths, shown in Figure 7. We find that although this emotion significantly decreases in the targeted treatment for both males and females (path *a*), it is the relationship between this emotion and valuations where the gender differences lie (path *b*). Specifically, for males there is a significant positive relationship between unactivated pleasant and valuations, whilst for females this relationship is very close to zero. We also see that the inclusion of

[17] Corresponding analysis for females is presented in the Appendix, table 5. We do not find any significant relationships between emotions and valuations in the targeted treatment models.

unactivated pleasant reduces the size of the observed treatment effect, as shown by the direct effect in parentheses. This is further evidence that, based on our data, this emotion appears a key part of the mechanism driving the carryover effect for males in the targeted treatment.

Risky



Ambiguous

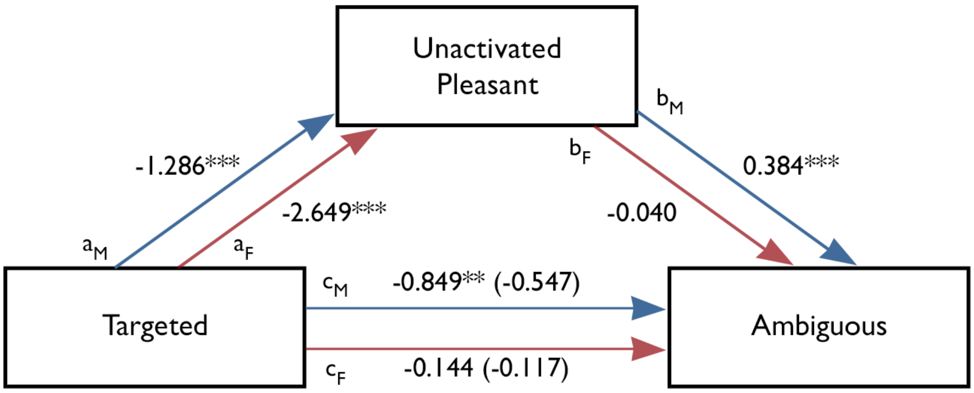


Fig. 7 Path diagrams for the effect of unactivated pleasant on risky and ambiguous valuations between the targeted treatment vs control, conditional on the other emotional variables in the model (indirect effects of other emotions not shown). Regression coefficients and significance for each path reported above each arrow. Direct effect given in parentheses. *p<0.10, **p<0.05, ***p<0.01

We now investigate whether there is an emotional basis to the carryover effect observed in the naturalistic treatment. Table 3 reports the *a* and *b* path coefficients for each emotion in models comparing the naturalistic treatment vs control for males. Looking at the 'increases' model, we find a number of *a* paths significant – disgust, fear and unpleasant, indicating that the naturalistic treatment produced a mixed emotional response for males relative to the control. However, no *b* paths are significant for either risky or ambiguous valuations. Furthermore, we see similar results for the 'decreases' model with a number of significant *a* paths, but no signifcant *b* paths. This brings us to our final key result of the paper – *although we observe stronger carryover effects in the naturalistic treatment, we cannot attribute this to variation in any of the emotions that we measured via self-reports.*[18]

Table 3 SEM path coefficients: males – naturalistic vs control

	Risky		Ambiguous	
	a	**b**	**a**	**b**
Increases Model				
High Activation	-0.146	0.025	-0.146	0.056
	(0.535)	(0.169)	(0.535)	(0.159)
Disgust	1.078**	-0.112	1.078**	-0.007
	(0.473)	(0.200)	(0.473)	(0.192)
Fear	0.864*	0.069	0.864*	-0.003
	(0.477)	(0.177)	(0.477)	(0.149)
Anger	0.054	0.075	0.054	0.043
	(0.464)	(0.146)	(0.464)	(0.154)
Unpleasant	1.057**	-0.215	1.057**	-0.203
	(0.458)	(0.189)	(0.458)	(0.179)
Decreases Model				
Activated Pleasant	-0.254	0.046	-0.254	-0.093
	(0.467)	(0.147)	(0.467)	(0.152)
Pleasant	-1.256***	0.056	-1.256***	0.104
	(0.479)	(0.143)	(0.479)	(0.140)
Unactivated Pleasant	-1.275***	0.111	-1.275***	0.123
	(0.490)	(0.143)	(0.490)	(0.147)
Low Activation	-0.610	-0.085	-0.610	-0.161
	(0.450)	(0.153)	(0.450)	(0.140)
Unactivated Unpleasant	-0.123	-0.119	-0.123	-0.043
	(0.676)	(0.112)	(0.676)	(0.109)

Standard errors are in parentheses. *p<0.10, **p<0.05, ***p<0.01

Given the rather surprising results we find from the SEM analysis that the targeted emotion fear cannot explain the carryover effect observed for males in the targeted

[18] Corresponding analysis is presented for females in the Appendix, Table 6 and here too we find little evidence to support connections between variations in valuations and specific types of emotions. We note that we do find some effect of anger of ambiguous valuations, although this is not large enough to show any observable change in valuations (POC=0.351, p<0.10).

treatment and no emotions appear to be responsible for the carryover effect in the naturalistic treatment, it is natural to consider whether this finding is robust. In relation to this, one key departure we make from the bulk of related literature is to measure emotional responses twice and then use the within-subject difference of these responses in the SEM analysis. An alternative method would be to only use our second emotions measure (i.e., final emotional state) thereby allowing the model to capture emotional effects beyond those attributable to our treatment manipulations (for example, this might better capture 'dispositional emotions' that may affect risk attitudes (Fehr-Duda et al. 2011)). As a robustness check, we re-estimated the SEM using the same econometric specifications as before, except for using final emotions, rather than changes in emotions. We present the results of this analysis, seeking to explain the treatment differences for males in terms of final emotions, in the Appendix, Tables 7 and 8. We find very similar results with the *b* path close to zero for fear in the targeted treatment for both risk and ambiguous valuations (Table 7) as well as insignificant *b* paths for emotions in the naturalistic treatment (Table 8). These results provide reassurance that our findings are robust to how emotional responses are defined.[19]

4 Discussion and conclusion

An established literature in psychology and more recently in economics, demonstrates the existence of emotional carryover effects. Our study contributes to the literature in two ways. Firstly, we examine whether carryover effects generalise from those associated with highly targeted emotional stimuli to more complex profiles of emotions associated with a naturalistic stimulus, based on reporting of real events. Secondly, using structural equation modelling, we test whether we can identify an emotional foundation to carryover effects by examining individual-level relationships between emotional responses and decisions.

We identify clear carryover effects but they are highly gender specific: only men are susceptible. Among males, they are also stronger in the naturalistic treatment and

[19] One difference from the final emotional states analysis is that the effect of unactivated pleasant in the targeted treatment is considerably weaker. This is due to the inclusion of the dispositional component, which correlates with risk differently compared to the rest of the variable and therefore can have potentially confounding effects. We see this as evidence to support our choice of using the within-subject difference in the analysis.

stronger in the context of ambiguity. For the targeted treatment, although we identify an emotional mechanism that explains the gender differences in the carryover effect, this is actually driven by a non-targeted emotion rather than the targeted emotion fear. Whilst we cannot definitively rule out that fear plays some role – partly because of strong correlations between emotions in the circumplex – our finding adds weight to doubts about any generic claim that fear influences risk attitudes. We note that a variety of previous studies that provide evidence for the influence of fear emotions in risky decision making do not directly associate measured fear emotions with risky decisions at the individual level – instead they infer this relationship through observations of average levels of reported fear and risk-taking across treatments. While a *prima facie* interpretation of such data is that changes in fear are causing changes in risk, our results which dig down from treatment level averages, fail to find corresponding support at the individual level. We recognise that at least some work has succeeded in finding some individual level connections from fear emotions to risk behaviours and a prominent example is Cohn et al. (2015), who primed fear responses among investment professionals. We note, however, that others have failed to replicate their results (see König-Kersting and Trautmann 2018; Alempaki et al. 2019) albeit with different subject pools. Notwithstanding the use of different subject pools, however, it is notable that Alempaki et al. (2019) are unable to observe differences in risky decisions across treatments even when fear was successfully manipulated between the treatments. Our study adds evidence to this ongoing debate about the emotional foundations of risky decisions, partly by further questioning the role of fear emotions and partly by identifying a new contender as an emotional driver. Specifically, in terms of the circumplex classifications, we identify a low activation and pleasant emotion as the uniquely significant emotional driver of responses in the targeted treatment (at least amongst males).

Despite the measurement of a full spectrum of emotions we are, however, unable to explain the carryover effect, generated among males by the naturalistic prime, through any of our measured emotions. We consider our contribution here to be tentative and exploratory, partly because mixed emotional responses are currently not that well understood (see Berrios et al. 2015 for a review) and additional tools may be needed to elicit them. For example, although self-reports are seen as a reliable way of measuring emotions, more advanced technological methods such as digital face recognition software may be able to give deeper insights through real-time analysis of facial expressions (e.g., den Uyl and van Kuilenburg 2005). In particular, recent developments in the identification of compound emotions i.e., emotional states formed from the combination of basic emotions (Du et al. 2014), could pave the way for a better understanding of the behavioural effects of more complex emotional stimuli.

Our study also sheds new light on another dimension of the literature. Consider, for example, Fessler et al. (2004), who also observe gender differences in the carryover effect on risk but find little difference in emotional responses across gender. By digging down to examine individual level responses, we demonstrated that even in the absence of gender differences in emotional responses to priming (i.e., along path *a* in our SEM model), there may be gender differences in the behavioural responses to specific emotions (i.e., along response path *b* in our model). The natural question to ask is why these differences in the carryover effect occur. Although this question is beyond the scope of the current study, we note an interesting paper by Yip and Côté (2013), who find that individuals with higher emotional intelligence can correctly identify the source of their emotions and are less susceptible to emotional carryover. With much of the literature finding that, on average, females score higher on emotional intelligence scales than males (see Joseph and Newman 2010, for a meta-analysis) this could offer a potential explanation for why females in our experiment did not exhibit emotional carryover.

Whatever the role of emotions in driving the carryover effects observed in our data – we *do* identify carryover effects and they are sizeable in magnitude for those prone to them (i.e., the males in our study). The finding that these effects are even larger for naturalistic (versus targeted) primes and larger for ambiguity compared to risk is a result of some potential practical significance. While previous research has demonstrated that highly targeted primes influence risk taking, our findings suggest that such effects can be even stronger and/or more prevalent as we move from the most highly stylised settings to incorporate closer approximations to the richness of the stimuli and the objects of choice that arise in the wild.

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Appendix

Table 4 List of variables in OLS regression models (from Table 1)

Variable	Description
Dependent Variables	
Risky	Valuations of risky lottery
Ambiguous	Valuations of ambiguous lottery
Independent Variables	
Targeted	1 if in the targeted treatment, 0 otherwise
Naturalistic	1 if in the naturalistic treatment, 0 otherwise
Female	1 if female, 0 otherwise
Order	1 if ambiguous-risky ordering, 0 otherwise
Health Science	1 if study medicine/health sciences, 0 otherwise
Nationality	1 if non-European nationality, 0 otherwise
Vegetarian	1 if vegetarian, 0 otherwise
BSE	1 if changed food habits due to BSE, 0 otherwise

Table 5 SEM path coefficients: females – targeted vs control

	Risky		Ambiguous	
	a	**b**	**a**	**b**
Increases Model				
High Activation	-0.228*	0.125	-0.228*	0.100
	(0.432)	(0.107)	(0.432)	(0.102)
Disgust	0.429**	-0.264	0.429**	-0.441*
	(0.195)	(0.244)	(0.195)	(0.234)
Fear	3.655***	-0.116	3.655***	-0.112
	(0.450)	(0.128)	(0.450)	(0.121)
Anger	0.728**	-0.061	0.728**	0.122
	(0.285)	(0.210)	(0.285)	(0.203)
Unpleasant	0.741**	0.320*	0.741**	0.260
	(0.338)	(0.189)	(0.338)	(0.178)
Decreases Model				
Activated Pleasant	-0.825*	-0.007	-0.825*	0.027
	(0.435)	(0.103)	(0.435)	(0.103)
Pleasant	-1.308***	0.087	-1.308***	-0.055
	(0.421)	(0.135)	(0.421)	(0.133)
Unactivated Pleasant	-2.649***	-0.022	-2.649***	-0.004
	(0.439)	(0.132)	(0.439)	(0.126)
Low Activation	-0.545	-0.109	-0.545	-0.100
	(0.392)	(0.137)	(0.392)	(0.137)
Unactivated Unpleasant	0.281	-0.025	0.281	0.073
	(0.560)	(0.067)	(0.560)	(0.065)

Standard errors are in parentheses. *p<0.10, **p<0.05, ***p<0.01

Table 6 SEM path coefficients: females – naturalistic vs control

	Risky		Ambiguous	
	a	**b**	**a**	**b**
Increases Model				
High Activation	0.281	0.033	0.281	-0.067
	(0.434)	(0.087)	(0.434)	(0.076)
Disgust	1.571***	0.048	1.571***	-0.018
	(0.386)	(0.114)	(0.386)	(0.115)
Fear	1.942***	0.037	1.942***	0.007
	(0.390)	(0.148)	(0.390)	(0.145)
Anger	0.932**	0.195	0.932**	0.376**
	(0.380)	(0.164)	(0.380)	(0.147)
Unpleasant	1.492***	-0.028	1.492***	-0.051
	(0.374)	(0.140)	(0.374)	(0.135)
Decreases Model				
Activated Pleasant	0.124	-0.077	0.124	-0.043
	(0.382)	(0.118)	(0.382)	(0.117)
Pleasant	-1.166***	-0.038	-1.166***	0.048
	(0.388)	(0.114)	(0.388)	(0.113)
Unactivated Pleasant	-1.650***	-0.026	-1.650***	-0.095
	(0.397)	(0.107)	(0.397)	(0.106)
Low Activation	-0.056	0.016	-0.056	-0.030
	(0.368)	(0.118)	(0.368)	(0.119)
Unactivated Unpleasant	-0.216	0.038	-0.216	0.156**
	(0.552)	(0.065)	(0.552)	(0.066)

Standard errors are in parentheses. *p<0.10, **p<0.05, ***p<0.01

Table 7 SEM path coefficients: final emotional states – males – targeted vs control

	Risky		Ambiguous	
	a	**b**	**a**	**b**
Increases Model				
High Activation	0.070	0.057	0.070	-0.028
	(0.404)	(0.098)	(0.404)	(0.124)
Disgust	0.304	0.098	0.304	-0.023
	(0.210)	(0.257)	(0.210)	(0.255)
Fear	1.413***	-0.024	1.413***	-0.004
	(0.423)	(0.104)	(0.423)	(0.106)
Anger	-0.086	-0.029	-0.086	0.033
	(0.223)	(0.242)	(0.223)	(0.240)
Unpleasant	-0.642**	-0.354*	-0.642**	-0.267
	(0.354)	(0.183)	(0.354)	(0.181)
Activated Pleasant	-0.309	-0.104	-0.309	-0.147
	(0.364)	(0.124)	(0.364)	(0.120)
Pleasant	-1.104***	-0.039	-1.104***	-0.011
	(0.411)	(0.112)	(0.411)	(0.110)
Unactivated Pleasant	-0.896**	0.211	-0.896**	0.235
	(0.429)	(0.153)	(0.429)	(0.149)
Low Activation	-0.443	-0.114	-0.443	-0.154
	(0.472)	(0.138)	(0.472)	(0.135)
Unactivated Unpleasant	-0.235	-0.072	-0.235	0.021
	(0.467)	(0.114)	(0.467)	(0.110)

Standard errors are in parentheses. *p<0.10, **p<0.05, ***p<0.01

Table 8 SEM path coefficients: final emotional states – males – naturalistic vs control

	Risky		Ambiguous	
	a	**b**	**a**	**b**
Increases Model				
High Activation	0.464	0.120	0.464	0.197
	(0.484)	(0.160)	(0.484)	(0.170)
Disgust	1.374***	-0.313*	1.374***	-0.171
	(0.414)	(0.187)	(0.414)	(0.199)
Fear	0.729	0.029	0.729	-0.118
	(0.471)	(0.170)	(0.471)	(0.177)
Anger	0.542	-0.222	0.542	-0.031
	(0.396)	(0.149)	(0.396)	(0.137)
Unpleasant	0.501	-0.131	0.501	-0.021
	(0.459)	(0.143)	(0.459)	(0.144)
Decreases Model				
Activated Pleasant	-0.082	-0.183	-0.082	-0.273
	(0.408)	(0.143)	(0.408)	(0.150)
Pleasant	-0.973**	0.218	-0.973**	0.160
	(0.462)	(0.115)	(0.462)	(0.142)
Unactivated Pleasant	-0.153	-0.115	-0.153	0.220
	(0.504)	(0.131)	(0.504)	(0.135)
Low Activation	-0.199	-0.104	-0.199	-0.231*
	(0.481)	(0.127)	(0.481)	(0.133)
Unactivated Unpleasant	-0.100	0.002	-0.100	0.067
	(0.565)	(0.104)	(0.565)	(0.107)

Standard errors are in parentheses. *p<0.10, **p<0.05, ***p<0.01

Electronic Supplementary Material

Online resource 1 Video stimuli information

Treatment	Description [Length] [minutes. seconds. frames]	Source
Control	Pre-edited video stimulus showing coral at the Great Barrier Reef. [1.07]	National Geographic Special - The Great Barrier Reef, Documentary Supplied by Lerner, J. Harvard University, Massachusetts, USA
Targeted	Begin clip at 41:01. At this point, a boy's hands are visible (one flat on the floor and the other in a fist). There are toy trucks and cars on a red, brown, and orange carpet. End clip at 42:19. At this point, an open door with a key in the lock is visible and one full second has passed since the boy has said "Mom, are you in there?" [1.18]*	The Shining. (1980). Film. Directed by Stanley Kubrick. DVD Release (2001). USA: Warner Bros
Naturalistic	Video stimulus created using five scenes from two documentaries. [2.16] 1. Introduction and interview BSE – UK [00.00.167-01.17.748] 2. Fatal disease interview BSE – UK [11.16.038-11.27.383] 3. CJD CJD Killer [01.39.943-01.52.691] 4. Science unknown CJD Killer [03.54.490-02.24.050] 5. Funeral ending CJD Killer [02.17.318-02.24.959]	BSE – UK. (2005). Documentary. Journeyman Pictures. YouTube, last viewed 26/05/2021 http://www.youtube.com/watch?v=R1LYzIfz8AA CJD Brain Killer. (2006). Documentary. WTHR Indianapolis. YouTube, last viewed 26/05/2021 http://www.youtube.com/watch?v=OE74S7fDDPc

*The targeted stimulus is identical to that used by Gross and Levenson (1995) and Rottenberg et al. (2007). Times vary slightly from the instructions given by these authors due to differences in DVD releases

Online Resource 2 Experimental instructions and materials

Below is a transcript of the experimental instructions and materials. Text in square brackets denotes instructions for the experimenter.

Introduction

Thank you for participating in this experiment. It is funded by the University of Nottingham. We ask that you do not read any of the materials until you are asked to do so and that you do not communicate with any other participants during the experiment. If you have any questions, please raise your hand.

Each participant is assigned a participant number. This is shown on the card on your desk. We will refer to this number when you collect your earnings for the experiment. Note that this is not the same as the number given on your computer screen, which will not be used in this experiment. Located in front of you on your desk, you will see a sheet entitled "Pre-Experimental Questionnaire". I will now read through this sheet out loud.

Pre-Experimental Questionnaire

The following set of words describes different feelings. Read each word in turn and using the scale shown below, indicate to what extent you have that feeling right now. A "0" on the scale means that you are not experiencing the feeling at all. An "8" means that you are experiencing the feeling more than ever before. For example, if you are feeling furious, you would put a number between 4 and 8 next to the word furious, depending on how furious you are.

Afraid ___	Confused ___	Happy ___	Repulsed ___
Amused ___	Contented ___	Indifferent ___	Sad ___
Angry ___	Depressed ___	Interested ___	Scared ___
Annoyed ___	Disgusted ___	Miserable ___	Surprised ___
Anxious ___	Elated ___	Neutral ___	Tense ___
Bored ___	Fearful ___	Passive ___	Uneasy ___
Calm ___	Furious ___	Relaxed ___	Unemotional ___

The Scale:

0	1	2	3	4	5	6	7	8
Not at all				To some extent				More than ever before

Do you feel any other emotions? ○ No ○ Yes

If so, what are the emotions and how much do you feel them on the scale?

____

The Experiment
The experiment consists of two studies. We are now going to tell you about the first study. We will tell you about the second study after the first one is completed. On your desk, there is a document entitled "The Video Study". Please look at the first page, which I will read out loud.

The Video Study
In this study, you are asked to view a short video clip. After the video clip, you will then be asked to reflect on what you have just seen, in writing, for about five minutes. Payment for this study is £2.50. This will be paid to you at the end of the experimental session, but only if you have completed the writing task.

Before viewing the video clip, we would like you to sit back and relax, while we turn the lights off [turn the lights off]. Try to clear your mind and take a couple of deep breaths. This will help you to focus on the clip [wait 10 seconds and start z-Tree on the client computers].

Now please put on the headphones in front of you and press the "start" button on the computer screen [video stimulus plays - wait until finished and turn the lights on].

Please return to "The Video Study" document and turn to the other side of the page, which I will read out loud.

[Control]: Using the scale below, please indicate to what extent you agree with the following statements:

- The topic described in the video clip is relevant to my interests ___
- The information given in the video clip is useful ___
- The type of music in the video clip is appropriate for this documentary ___
- The type of narration used in the video clip is appropriate for this documentary ___

1	2	3	4	5
Strongly Agree	Slightly Agree	Uncertain	Slightly Disagree	Strongly Disagree

In your opinion, what improvements could be made to this documentary to increase viewing? Do you have any other comments about the video clip? [Wait 5 minutes and then prompt the subjects to finish what they are writing].

[Targeted Treatment]: Write about how you would feel if you were the person depicted in the video clip.

[Naturalistic Treatment]: Write about how you feel about the risk of contracting a disease similar to that depicted in the video clip.

That is the end of the first study. We will now collect in the sheets that you have completed and hand out a new document relating to the second study [collect in the sheets and hand out "The Decision Making Study"].

The Decision Making Study [Task Order: risky→ambiguous]

We will now tell you about the second study. On your desk, there is a document entitled "The Decision Making Study". I will now read this out aloud.

Outline of the Study and Payment
In this study, you will be asked to make choices between lotteries and various sure amounts of money. There are two parts to this study, each comparing a different lottery to the same sure amounts of money.

Payment for the study will be determined as follows: You will make a total of 50 choices across the two parts of the study. Your payment will depend on ONE of the choices you make, which could come from EITHER part of the study. This is called the "payment choice". You will not discover which choice is your payment choice until all 50 choices have been made. At the end of the experiment you will draw a ball from a bag containing 50 balls with the numbers 1 to 50. The number on this ball will be your payment choice. For example, if you select number 3 from the bag, then choice 3 will be used to determine your earnings in the study. If you chose the lottery, then you will play it out and you will either win or lose depending on chance. If you chose the sure amount, then you receive the corresponding amount of money.

As you make your choices in this study keep in mind that any one of them could turn out to be your payment choice. We therefore suggest that you treat each choice as if it is the one that will determine your earnings for the study. Please turn to the second page entitled "The Decision Making Study – Part 1".

Part 1
Consider the following options:

[Risky Task]: Option A is a lottery which gives you a 50:50 chance of winning £12 or nothing. If you choose this option, then you will draw out a disc from a bag, which contains exactly 10 blue and 10 red discs. Before you draw out a disc, you choose a colour and announce it. If the colour you announced matches the colour you draw, you win £12. If the colours do not match, then you win nothing.

Option B gives you a fixed amount of money for sure.

Here is the bag associated with option A, which we will call "bag A". Here are the 10 blue and 10 red discs going into the bag (show bag A and the discs going into the bag).

An example of the type of choice you will be asked to make is as follows:

Choice	Option A	My Choice: Option A	Option B	My Choice: Option B
3	Play Option A	○	Receive £3.50 for sure	○

If you choose option A in this example, then you are telling us that you prefer the lottery (a 50:50 chance of winning £12 or nothing) to receiving £3.50 for sure. In this case, you should record your choice by placing a cross in the circle under "My Choice: Option A". If you choose option B, then you are telling us that you prefer to receive £3.50 for sure rather than the lottery. In this case, you should record your choice by placing a cross in the circle under "My Choice: Option B". Please turn to the other side of the page entitled "Decision Sheet Part 1". You will see a set of 25 choices. At the top of the page it says:

For each of the choices below, please indicate whether you prefer to play Option A (a lottery which gives you a 50:50 chance of winning £12 or nothing) OR to take Option B (a sure amount of money). Please record each choice by placing a cross in the circle next to your preferred option. Notice that for each of the 25 choices, option A is always exactly the same lottery, but the sure amount of money associated with option B increases as you go down the page. Remember that one of your choices from either part 1 or part 2 of this study will be for real and that will determine your earnings. Do you have any questions? Now please make all 25 choices in turn. If you change your mind, make sure that your final choices are absolutely clear [wait 5 minutes or until everybody has completed the task]. Please turn to the third page entitled "The Decision Making Study – Part 2".

Part 2
Consider the following options

[Ambiguous Task]: Option C is a lottery which gives you a chance of winning £12 or nothing, although the exact probability of winning is unknown. If you choose this option, then you will draw out a disc from a bag, which contains exactly 20 coloured discs. Some are blue and some are red, but we will not tell you the proportions of blue and red discs. Before you draw a disc, you choose a colour and announce it. If the colour you announced matches the colour you draw, you win £12. If the colours do not match, then you win nothing.

Option B gives you a fixed amount of money for sure.

Here is the bag associated with option C, which we will call "bag C". There are the 20 blue and red discs, but we will not tell the proportions of blue and red discs (show bag C with the discs already in the bag).

[All other aspects of this task are the same as Part 1]

That is the end of the second study. We will now collect in the sheets that you have completed and hand out a new document [collect in the sheets and hand out the "Post-Experimental Questionnaire"].

Post-Experimental Questionnaire
On your desk, there is a document entitled "Post-Experimental Questionnaire". There are two parts to this survey. The first part is related to the video study and the second part is a demographic questionnaire. Please fill in both parts [wait 10 minutes or until everybody has finished the "Post-Experimental Questionnaire" and hand out the receipt forms].

Recall the first study, in which you watched a video clip and undertook a writing task related to the video clip. The following set of words describes different feelings. Read each word in turn and using the scale shown below, indicate to what extent the video clip and the writing task prompted each feeling. A "0" on this scale means that you did not experience the feeling at all. An "8" means that you experienced the feeling more than ever before. For example, if the video clip and writing task made you feel furious, you would put a number between 4 and 8 next to the word furious, depending on how furious you were.

Afraid ___	Confused ___	Happy ___	Repulsed ___
Amused ___	Contented ___	Indifferent ___	Sad ___
Angry ___	Depressed ___	Interested ___	Scared ___
Annoyed ___	Disgusted ___	Miserable ___	Surprised ___
Anxious ___	Elated ___	Neutral ___	Tense ___
Bored ___	Fearful ___	Passive ___	Uneasy ___
Calm ___	Furious ___	Relaxed ___	Unemotional ___

The Scale:

0	1	2	3	4	5	6	7	8
Not at all				To some extent				More than ever before

Did you feel any other emotions during the video clip? ○ No ○ Yes

If so, what were the emotions and how much did you feel them on the scale?

____

Have you seen the video clip before? ○ No ○ Yes

Demographic Questionnaire
Please complete the following details and answer the questions below:

Age: ____
Gender: ____
Subject Studying: _______________________________
Nationality: _____________________________________

1. Do you enjoy watching horror films? ○ No ○ Yes ○ Indifferent
2. Do you enjoy watching wildlife documentaries? ○ No ○ Yes ○ Indifferent
3. Using the scale below, how often do you do the following activities to keep up to date with the news?

Read Newspapers ___
Watch Television ___
Surf the Internet ___
Listen to the Radio ___

1	2	3	4	5
Daily	A Few Times A Week	Weekly	Fortnightly	Never

4. If you read newspapers to keep up with the news, which newspapers do you read?

____

5. If you watch television to keep up with the news, which channels do you watch?

____

6. If you surf the internet to keep up the news, which websites do you visit?

____

7. If you listen to the radio to keep up with the news, which radio stations do you listen to?

____

8. Are you a vegetarian? ○ No ○ Yes

9. How well informed would you say you are about food safety?

○ Not at all ○ Slightly ○ Moderately ○ Highly

10. How concerned are you about food safety in your daily life?

○ Not at all ○ Slightly ○ Moderately ○ Highly ○ Extremely

11. Have you ever changed your food consumption habits due to a food safety issue?

○ No ○ Yes

12. If you answered yes to the previous question, could you tell us which issue(s) and whether this was a temporary or permanent change in your food consumption habits?

____

13. How do you see yourself: Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? Please respond by putting a cross in one of the circles below. A "0" means that you are unwilling take risks. A "10" means that you are fully prepared to take risks.

0	1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○	○
Unwilling to take risks										Fully prepared to take risks

Thank you for taking part in this experiment. Please wait for your participant number to be called to determine your earnings for the decision making study and to be paid for the entire experimental session.

We will now call you individually by participant number to determine your earning for the decision making study. While you are waiting, please fill in your personal details of the receipt form, which has been placed on your desk. When your number is called, please come to the front desk with both "The Post-Experimental Questionnaire" and the receipt form. You will be paid for the entire session and then you may leave the experiment. Thank you for participating in this experiment. We will now call participant number…