Title: Out of control mortality matters: the effect of perceived uncontrollable mortality risk on a health-related decision

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Abstract

Prior evidence from the public health literature suggests that both control beliefs and perceived threats to life are important for health behaviour. Our previously presented theoretical model generated the more specific hypothesis that uncontrollable, but not controllable, personal mortality risk should alter the payoff from investment in health protection behaviours. We carried out three experiments to test whether altering the perceived controllability of mortality risk would affect a health-related decision. Experiment 1 demonstrated that a mortality prime could be used to alter a health-related decision: the choice between a healthier food reward (fruit) and an unhealthy alternative (chocolate). Experiment 2 demonstrated that it is the controllability of the mortality risk being primed that generates the effect, rather than mortality risk per se. Experiment 3 showed that the effect could be seen in a surreptitious experiment that was not explicitly health related. Our results suggest that perceptions about the controllability of mortality risk may be an important factor in people's health-related decisions. Thus, techniques for adjusting perceptions about mortality risk could be important tools for use in health interventions. More importantly, tackling those sources of mortality that people perceive to be uncontrollable could have a dual purpose. Making neighbourhoods and workplaces safer would have the primary benefit of reducing uncontrollable mortality risk, which could lead to a secondary benefit from improved health behaviours.

Introduction

It is important to understand what factors influence health behaviour. Some of the leading causes of death in developed countries are a result of preventable unhealthy behaviours such as inactivity, poor diet, smoking and alcohol consumption (Mokdad, Marks, Stroup, & Gerberding, 2004). Such preventable behaviours also cause a substantial burden on healthcare systems. For example, obesity-related health problems, such as type 2 diabetes and heart disease, are becoming a major issue in the UK, with 61% of adults and 30% of children in England being overweight or obese. Such obesity and overweight related health problems are estimated to cost the NHS over £5 billion a year (Report, 2011).

A substantial research effort has been made towards improving the efficacy of health messages to promote behaviour change. One of the key theoretical ideas to emerge from this research has been the importance of perceived control, and of efficacy, in influencing health behaviour. Other research themes focus on mortality salience and perceived threat. Below, we introduce some of the main theoretical approaches in this area, before discussing the more specific predictions made by our previously published theoretical model (Nettle, 2010). Our model generated the hypothesis that it should be the sense that mortality risk is not controllable, and not the existence of mortality risk per se, that should cause people to reduce their efforts to behave in a health way. We call this the Uncontrollable Mortality Risk Hypothesis. We report three experiments that tested the predictions of our model and discuss our results in the context of the other theoretical frameworks, which we will outline, below.

Health Locus of Control and health behaviour

Health Locus of Control describes the extent to which a person believes that their health is determined by the actions of individuals, rather than by chance, and whether the locus of that control is internal (a result of their own actions) or external (resulting from the actions of others). Prior findings suggest that Health Locus of Control is important both for health outcomes (e.g. Burker, Evon, Galanko, & Egan, 2005; Poortinga, Dunstan, & Fone, 2008) and for health behaviours (Reitzel et al., 2013; Wardle & Steptoe, 2003). That is, people who feel in control of their lives and health outcomes (have an internal Locus of Control) exhibit healthier behaviours. Previous work has examined the advantages of tailoring public health messages to people's Health Locus of Control (e.g. Holt, Clark, Kreuter, & Scharff, 2000; Williams-Piehota, Schneider, Pizarro, Mowad, & Salovey, 2004). However, these studies tend to implicitly assume that Health Locus of Control is a stable individual trait, rather than a flexible response to information from the environment. There is less research which attempts to induce a sense of control (though see one experiment by (Kong & Shen, 2011).

Fear appeals and the effect of perceived response efficacy on health behaviour

A related, but distinct area of work focusses on how the impact of fear appeals (messages intended to persuade people to change their behaviour by inducing fear regarding health threats) can be improved by suggesting that the recommended response to a threat will be highly effective. A number of theoretical frameworks have been used in the fear appeal literature and many of them emphasise the importance of control (which they call efficacy of threat response and personal efficacy) in eliciting behaviour change (Witte & Allen, 2000). These theoretical frameworks include the Extended Parallel Process Model and Protection

Motivation Theory and are comprehensively reviewed by Witte and Allen (2000). In general, these theories suggest that if there is a strong threat to health and a highly effective solution is available, then people will act to use that solution. The Extended Parallel Process Model states that if people perceive a strong threat (which must be of sufficient severity, and to which they must feel personally susceptible) and they feel that they are able to respond adequately to that threat (personal efficacy and response efficacy) they will act to reduce the threat. However, if the message offers the threat without suggesting that the solution is effective, behaviour change is less likely to occur. That is, these models state that threat serves to motivate people towards possible solutions, but that if people do not feel that the solution will be effective, they are unlikely to act (Goei et al., 2010; Lewis, Watson, & White, 2013; Witte & Allen, 2000).

Terror Management Theory and Health Behaviour

Another field that examines the impact of threat on behaviour is Terror Management Theory (Greenberg, Pyszczynski, & Solomon, 1986). Terror Management Theory proposes that people have a fear of death, which causes anxiety or terror when they are made aware of their vulnerability. It suggests that, when people are made to think about their mortality (a condition known as mortality salience) they will attempt to buffer their anxieties and to suppress conscious thoughts of death. Goldenberg and Arndt (2008) extended Terror Management Theory to create the Terror Management Health Model for behavioural health promotion. They proposed that conscious thoughts about death (as elicited by many fear appeals) would trigger behavioural responses (in this case, health improving behaviour) aimed at reducing the threat, and thus the accompanying fear of death. However, their model states that when thoughts about death are unconscious, people should act not to reduce the threat to their life, but to direct their efforts to maintaining a sense of meaning and self-esteem.

The Uncontrollable Mortality Risk Hypothesis

We previously presented a theoretical model (Nettle, 2010) suggesting that differences in health behaviour could be explained by differential exposure to uncontrollable mortality risk: The Uncontrollable Mortality Risk Hypothesis. The hypothesis suggests that people who are likely to be killed by factors beyond their control should be less motivated to invest effort in looking after their future health. This makes intuitive sense when you consider that people who are exposed to high uncontrollable mortality risk are less likely to survive to reap the rewards of their healthy behaviour, given that that reward is likely to be garnered in the far future. To give a caricatured example, there is little point in investing in a healthy diet or exercise routine when you feel you could be killed by an erupting volcano at any moment. Unfortunately, this creates a two-fold problem. People who feel that they cannot control a large part of their mortality risk will invest less in their future health, thus increasing their risk of death due to factors within their control. This increases their overall mortality risk, further compounding the problem. The implication of this is that mitigating sources of uncontrollable mortality risk would lead to improved health behaviour, offering a two-fold benefit: Uncontrollable mortality risks would be reduced and people would take better care of their own health.

We previously tested predictions from the Uncontrollable Mortality Risk Hypothesis using survey data (Pepper & Nettle, 2014a). We found that people who perceived that a higher portion of their personal mortality risk was beyond their control were less motivated to invest effort in looking after their health.

How the Uncontrollable Mortality Risk Hypothesis differs from other perspectives

The Uncontrollable Mortality Risk Hypothesis differs from theories in the fear appeal literature (e.g. The Extended Parallel Process Model or Protection Motivation Theory) because these theories focus on the controllability of the specific aspects of health which are being communicated and not on the controllability of mortality risk more generally. That is, models in the fear appeal literature predict that perceived control (personal efficacy or response efficacy) over a specific risk will only affect behaviours related to that risk. For example they predict that, the belief that you can control your risk of diabetes by modifying your diet will affect your motivation to eat healthily. By comparison, our hypothesis predicts that perceived control over mortality risk should alter motivation towards healthy behaviour in general – even when the healthy behaviour is not a recommended response to that risk. For example, our hypothesis predicts that if you believe you are unable to control your risk of falling victim to a volcanic eruption, you should be less inclined to make an effort to exercise. Exercise is not a recommended response to reduce the threat posed by a volcano and yet, we should expect the controllability of one risk to influence the payoff to investing in mitigating the other. That is, uncontrollable threats can diminish the efficacy of responding to other, more controllable ones.

The Uncontrollable Mortality Risk Hypothesis also differs from the Terror Management Health Model. The Terror Management Health Model predicts that conscious mortality thoughts will lead to improved health behaviour, while unconsciously primed mortality will lead people to redirect efforts in ways which buffer their self-esteem or reinforce their world view. Meanwhile, the Uncontrollable Mortality Risk Hypothesis predicts that is it is not mortality salience per se which should be important, but the extent to which the mortality being primed is perceived as being controllable.

In summary, there is a range of theories used to explain behavioural responses to health messages involving threat and control. Our Uncontrollable Mortality Risk Hypothesis specifically predicts (1) that cueing the perception of increased uncontrollable mortality risk will decrease motivation to perform all health-protecting behaviours, including those that have nothing to do with the particular source of mortality that was cued; and (2) that cueing mortality risk per se will not affect health behaviours. Rather, it is the controllability of those risks that will be influential in determining healthy decisions.

Here, we present three experiments testing these predictions. The first was a test of whether a mortality prime can be used to influence a health-related decision – the choice between a healthy food reward and an unhealthy one. The second experiment used the same method but with primes that separated out the effects of controllability from those of mortality priming. That is, we tested whether there is an effect of mortality salience per se, or whether it is the controllability of mortality risk which is important. The third study aimed to rule out the possibility that the results of the first two studies were due to demand characteristics; the participants did not know that they were taking part in an experiment and health was never explicitly mentioned.

Experiment 1: The effect of priming uncontrollable mortality on health-related decisions

Experiment 1 tested whether an uncontrollable mortality prime would affect a simple health-related decision: the choice between a reward of fruit (the healthy option) and chocolate (the unhealthy option). For this proof-of-concept experiment, we chose primes that we expected to produce the most extreme results. One prime suggested that causes of death were uncontrollable, and that people sharing the participant's demographics were dying younger than average (uncontrollable short life prime). The other prime suggested both that causes of death were controllable and that people sharing the participant's demographics were living longer than average (controllable long life prime). We predicted that the combination of an expectation of living longer and of being able to control the likelihood of longevity would incentivise healthier behaviour. Thus, we predicted that participants would report stronger intentions towards healthy behaviour in the controllable long life treatment than in the uncontrollable short life treatment. We also predicted that participants in the controllable long life treatment would be more likely to choose fruit than participants in the uncontrollable short life treatment.

Methods, materials and analysis

All of our experiments (1, 2 & 3) received ethical approval from the Newcastle University Faculty of Medical Sciences ethics committee (reference 00554). Participants for experiments 1 and 2 were recruited using the Crowdflower crowdsourcing platform (http://crowdflower.com). The Crowdflower platform allows contributors to perform small online tasks – including participating in experiments – for credits, which can be converted to cash. Participants followed a link to the experiment, which was generated using Qualtrics (version 2013, http://www.qualtrics.com). Participants were presented with an information screen which contained statements about ethics and privacy and provided contact details for the experimenters. The introduction to the study read, "Welcome to the UK health behaviours study. We want to understand why people in some parts of the UK live longer than others do. (For recent information about differences in life expectancies across the UK, please see this BBC news article.)" The news article which the information page linked to was about Public Health England's Longer Lives website (http://longerlives.phe.org.uk/), which provides a map of the regions of England, ranked by rates of premature mortality. Experiment 1 was launched on July 2nd, 2013, less than a month after this map had been headline news. The map was therefore used as a timely cover story for the experiment. Participants completed an electronic consent form.

We needed to ensure that our participants were from the UK, because the primes were based on UK postcode statistics. Thus, after completing the consent form, participants were moved onto a location-check screen, which read "Your IP address indicates that you are currently in [LOCATION]." Qualtrics was programmed to present the location from which the participant was accessing the web page, based on their Internet Protocol address (IP address). The rest of the screen read, "We only need people who live in the UK to complete our survey. However, we understand that you may be taking the survey whilst away from home. If you are not from the UK we can still generate a code so you get credit for trying to take part, but we will not be able to use your answers as part of our study. Do you currently live in the UK?" Participants then had the option to click "Yes" or "No." Participants who clicked "no" were filtered straight to the debriefing screen and were given Crowdflower credit for their time.

Participants who declared themselves to be from the UK were moved on to a screen which asked for their age, gender and current postcode. After giving this information, all participants moved onto a screen which presented a "loading" animation, timed to auto-progress after 12 seconds. The message under the animation read, "Thanks for submitting your information. It may take a while to match it to health data for people of your age and gender in your postcode area. Please wait a few moments." This loading screen was designed to create the impression that the demographic information given by participants was being used to look up real information about life expectancies for people who shared their characteristics. After the loading screen, participants were randomly allocated to one of the primes.

In each prime, the message fed back to the participant used piped text to display a message tailored with the age, gender and postcode which had been entered previously. This was done to make the participants feel as though the information about their mortality risk was personal to them.

Uncontrollable short life prime

The uncontrollable short life priming screen read as follows: "Statistics indicate that, on average, [age] year-old [male/female]s in your postcode area [(postcode)] die 13 years younger than [male/female]s of the same age in the rest of the UK. The reasons for this are unclear and may be due to factors beyond individual control, such as traffic accidents and air pollution. We want to understand more about why this is happening. Please answer the following questions about your health."

Controllable long life prime

The controllable long life priming screen read: "Statistics indicate that, on average, [age] year-old [male/female]s in your postcode area [(postcode)] live 13 years longer than [male/female]s of the same age in the rest of the UK. The reasons for this are unclear and may be due to individual behaviours, such as diet and exercise habits. We want to understand more about why this is happening. Please answer the following questions about your health."

Outcome variables

Following the priming screen, participants moved on to the health behaviour questions. They were asked to answer some simple scale-based (0-100) questions about their intended future health behaviour (see online supporting information for full questionnaire). We refer to the answers to these as self-reported health intentions. The first was a general question, "How much effort will you put into looking after your health and safety over the coming week?" The second question was about diet, "How likely is it that you will eat 5 portions of fruit or vegetables per day over the coming week?" The third question was about exercise, "How likely is it that you will do 30 minutes or more of physical exercise three times over the coming week?" The final question was about alcohol use, "How many units of alcohol are you likely to drink over the coming week? (One standard glass of wine or pint of lager is about 2.3 units.) If you are unsure about how many units of alcohol are in different drinks, you can calculate them here: NHS Units Calculator." (We provided a link to the NHS Units Calculator - http://www.nhs.uk/Tools/Pages/Alcohol-unit-calculator.aspx - to allow participants who were uncertain about how many units are contained in a drink to calculate their intake.) Finally, after the questionnaire was completed, participants were moved onto a screen, which was ostensibly separate to the questionnaire. On this screen, participants were thanked for taking part in the study. They were told that as an extra thank you for taking part, they could leave a contact email address or telephone number and be entered into a prize draw. They were asked to select the prize which they would prefer to win. The options were "A Riverford Farm Organic Fruit box worth £11", or "A Thorntons Summer Chocolate Collection box worth £11." This was our behavioural outcome measure – their choice between a healthier prize (fruit) and an unhealthy one (chocolate). After choosing their reward, participants moved on to a debrief screen, which made it clear that the feedback given about life expectancies in their area had been false (debrief text is included in the questionnaire shown in the online supporting information).

Covariates

The age and gender that the participants entered at the beginning of the experiment were used as covariates. In addition, their postcode was used to generate a deprivation rank for their current residential neighbourhood. This was done using the Office for National Statistics' Indices of Multiple Deprivation (Mclennan, Barnes, Noble, Davies, & Garratt, 2011). The IMD identify the most deprived areas of the country, by combining a range of economic and social indicators into a single score. Areas can be identified by their IMD rank, which is considered to be a useful objective measure of an individual resident's socioeconomic status (Danesh et al., 1999). Finally, we used the length of time the participant spent on the participant information screen and on the priming screen as covariates. We did this because participants who spent more time reading the cover story and feedback information may have bought into the cover story to a greater extent and thus may have been more strongly primed.

Exclusions

We requested 100 responses through Crowdflower. However, we were compelled to exclude some of the data. A key element of the prime was that the mortality risk information was tailored to participants' postcodes. Therefore, we only used data for which we could be reasonably certain that the participants had entered their real postcode. We excluded data from our analysis if: 1) The participant's postcode was missing or was not a valid UK postcode, 2) the participant's IP address was not UK based, or 3) the participant IP address recorded by Crowdflower did not match that recorded by Qualtrics (indicating possible use of a proxy server or an attempt to take the same survey multiple times from different machines in order to get extra Crowdflower credit.) After these exclusions we were left with 72 responses.

Analysis

All analysis was carried out in SPSS version 19. The effects of our covariates (age, gender, Index of Multiple Deprivation rank, and time spent on information and priming pages) on reported health intentions were assessed using a GLM. The covariates that had a significant effect on self-reported health intentions were then included in our main statistical model. That is, the main model includes treatment effects and also, as controls, for all covariates that had a significant effect in the covariates-only model.

The effects of treatment on reward choice were evaluated using binary logistic regression. As in the GLM, we first assessed which, if any, of the covariates had an effect on reward choice in order to include them in the main model as needed. The data for all experiments reported in this paper can be accessed as part of the online supporting information.

Results

Descriptive statistics

35 participants were randomly allocated to the controllable long life treatment and 37 to the uncontrollable short life treatment. 39 participants were male and 33 were female. Ages ranged from 19 to 69 years. Time spent on the information page ranged from 0-199 seconds, with a mean of 20 seconds. Time spent on the priming pages ranged from 9-138 seconds, with a mean of 22 seconds. Participants' neighbourhood IMD ranks ranged from 444 to 31329 (of a possible 1-32482) with a median of 13163.

There was no significant difference in the ages of the participants across treatments (t_{70}=-0.50, p=0.62). There was also no difference between treatments in the time spent on the information page (t_{69}=0.70, p=0.48) or the priming page (t_{69}=1.09, p=0.28). The IMD rank of participants' postcodes did not vary across treatments (t_{61}=-0.81, p=0.42). There was no difference in the distribution of the sexes of participants across treatments (Fisher's exact, p=0.35).

Main results

There was no effect of any of our covariates on self-reported health intentions. Thus, the covariates were not included in the main model (table 1). There was also no effect of treatment on the self-reported health intentions (table 1, table 2).

None of the covariates showed an effect on choice of fruit, rather than chocolate, as a reward. However, there was an effect of treatment on reward choice (table 3). Of the participants in the uncontrollable short life treatment, 31% (n=10) chose fruit as a reward. In the controllable long life treatment, 57% (n=20) of the participants chose fruit (figure 1, table 3).

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Table 1. Means and standard deviations for self-reported health intentions in the controllable long life prime and uncontrollable short life treatments.

Model 1: Covariates only	**F**	**p**	η_p^2
Age	1.43	0.240	0.115
Sex†	0.74	0.568	0.063
IMD rank	0.38	0.821	0.033
Time on info page	1.67	0.173	0.132
Time on priming page	1.56	0.202	0.124

df=4, error=44, p = significance (*p≤0.05), †The reference category is female

Model 2: Model for treatment effect†	**F**	**p**	η_p^2
Treatment	1.47	0.223	0.093

df=4, error=57, p = significance (*p≤0.05).

Table 2. GLM results showing the effect of the covariates (model 1) and the controllable long life prime and uncontrollable short life treatments (model 2) on self-reported health intentions.

Reported health intention	Treatment	Mean	Standard deviation
Effort in looking after health	Uncontrollable short life	62.67	26.72
	Controllable long life	67.93	20.96
Intention to eat 5 portions of fruit and veg per day	Uncontrollable short life	47.94	34.29
	Controllable long life	63.17	26.80
Intention to exercise three times over the coming week	Uncontrollable short life	60.70	33.82
	Controllable long life	56.03	31.85
Intended units of alcohol intake over the coming week	Uncontrollable short life	5.69	7.08
	Controllable long life	8.03	16.18

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Table 3. Binary logistic regression results showing the effect of the covariates (model 1) on the odds ratios for selecting fruit over chocolate and the effect of the controllable long life prime compared with the uncontrollable short life prime (model 2).

Model 1: Covariates only	Odds ratio	Lower CI	Upper CI	p
Sex[†]	1.62	0.53	4.94	0.394
Age	1.01	0.97	1.06	0.582
Neighbourhood deprivation score	1.00	1.00	1.00	0.779
Time spent on information page	1.00	0.97	1.04	0.795
Time spent on priming page	0.96	0.91	1.01	0.115

Model 2: Model for treatment effect	Odds ratio	Lower CI	Upper CI	p
Treatment	2.93	1.08	8.00	0.036*

CI = 95% confidence interval, p = significance (*p≤0.05)

[†]The reference category is female.

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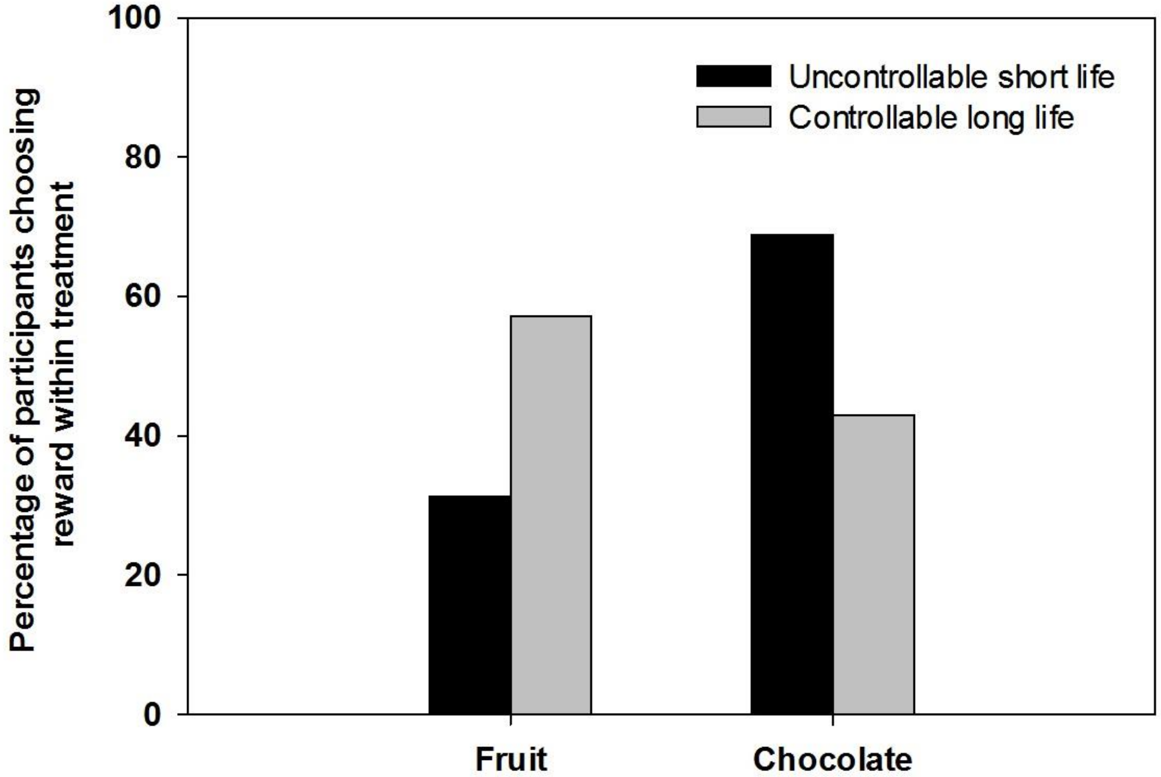

Figure 1. The percentage of participants who chose fruit or chocolate rewards after exposure to either a controllable long life prime or uncontrollable short life prime.

Experiment 1 discussion

Contrary to our prediction, the results of experiment 1 demonstrated no effect of our primes on self-reported health intentions. However, there was an effect of our primes on a health-related decision - the choice of a fruit versus chocolate. The effect of treatment on reward choice was notable. The proportion of participants who chose fruit went up from 31% in the uncontrollable short life prime to 57% in the controllable long life treatment (an 84% relative increase). The fact that there was an effect of the prime on the behavioural measure but not the self-report measures suggests that the priming may produce an implicit, automatic response, rather than an explicit, reasoned one. This is interesting, given that evidence suggests that a number of health-related decisions involve implicit, automatic processes (Gibbons, Houlihan, & Gerrard, 2009; Sheeran, Gollwitzer, & Bargh, 2013)

Several aspects of experiment 1 needed improving upon. The experiment had no control condition, so we could not say what the baseline preferences with no priming would be. Our design also did not separate the effects of priming mortality per se from those of controllability, since our two primes differed in both these dimensions. Finally, it is possible that the effect seen in experiment 1 was actually a normative one: In the uncontrollable short life condition, the health behaviour of others was not mentioned. Meanwhile, in the controllable condition, the health behaviour of others was described. Social norms are thought to influence health behaviour (Ball, Jeffery, Abbott, McNaughton, & Crawford, 2010; Wood, Brown, & Maltby, 2012), and it is possible our participants were automatically conforming to the norms described in the primes. It was important to rule out this potential confound. Thus, in experiment 2, we added a control treatment, and designed new primes which separated the effect of mortality salience from that of controllability. Since the norms contained in the two controllable treatments were opposing, this also addressed the potential of a confounding normative effect.

Experiment 2: Separating the effects of mortality priming from those of controllability priming

Our second online experiment built upon our first. We added a control condition in which participants entered their demographic data and postcode, but received no feedback about life expectancy for people in their demographic. We also separated out the life expectancy component of the message (whether it suggested that people were living for more or less time than others) from the controllability of the causes of mortality. Thus, there were five conditions: uncontrollable short life, uncontrollable long life, controllable short life, controllable long life and a control condition. Our Uncontrollable Mortality Risk Hypothesis (see Introduction) predicts that the controllability of the primed mortality risk should be more important than whether or not mortality per se is made salient. Thus, we hypothesized that participants in the two controllable treatments would be more likely to choose fruit than participants in the uncontrollable treatments, regardless of whether the prime suggested that people were living longer or dying younger. However, in light of the result of experiment 1, we expected that we might see no effect of treatment on self-reported health intentions.

Methods and materials

Participants were recruited using Crowdflower and followed a link to a Qualtrics-based experiment, as in experiment 1. The participant information, consent form and location check screens were the same as those used in experiment 1. As with the first experiment, the participants were asked to enter their demographic information, which led them to a "loading" animation, timed to auto-progress after 12 seconds. After the loading screen, participants were randomly allocated to one of the treatments. In each prime, the message fed back to the participant included the postcode which they had entered previously. Again, this was done to make the participants feel as though the information about their mortality risk and its causes was personal to them. While the primes in experiment 1 were personalised to age, gender and postcode, these primes were only personalised by postcode. In addition, the reference frames were changed. We did this in order to test a form of words which would not require deceit, because in our later field study (experiment 3, see below), there would be no opportunity to debrief participants. This meant shifting the reference frame (either the same residential area in the year 2000, or other UK regions in the present), so that deceit was not necessary (because it is true that people in Tyne & Wear are living longer than they were in the year 2000, but also, not as long as others in the UK – see experiment 3).

Control condition

In the control condition, there was no feedback after the participant entered their information. They simply waited for 12 seconds at the loading screen and then saw the message, "Thanks for submitting your basic information. Please answer the following questions about your health."

Uncontrollable short life prime

The uncontrollable short life prime consisted of a message saying that people living in the participant's postcode area were dying younger than people in other parts of England. The reasons given for this were beyond the participant's control – in this case, high rates of violent crime and traffic accidents: "Statistics indicate that, on average, people in your postcode area [(postcode)] die younger than people in other parts of England. This seems to be because there are higher rates of traffic accidents and violent crime than in other areas. Please answer the following questions about your health."

Uncontrollable long life prime

The uncontrollable long life prime said that people living in the participant's postcode area, were now living longer than they had in the year 2000. Again, the reasons given were beyond individual control: "Statistics indicate that, on average, people in your postcode area [(postcode)] are living longer now than they were in the year 2000. This seems to be because of improvements in road safety and reductions in violent crime. Please answer the following questions about your health."

Controllable short life prime

The controllable short life prime stated that people living in the participant's postcode area, were dying younger than people in other parts of England. This time reasons given were within individual control – in this case, individual health behaviours: "Statistics indicate that, on average, people in your postcode area [(postcode)] die younger than people in other parts of England. The reasons for this are unclear, but it may be due to individual behaviours, such as diet and exercise habits. We want to understand more about why this is happening. Please answer the following questions about your health."

Controllable long life prime

The controllable long life prime consisted of a message saying that people living in the participant's postcode area, were now living longer than they had in the year 2000. Again, the reasons given were controllable: "Statistics indicate that, on average, people in your postcode area [(postcode)] are living longer now than they were in the year 2000. The reasons for this are unclear, but it may be due to individual behaviours, such as diet and exercise habits. We want to understand more about why this is happening. Please answer the following questions about your health."

Outcome variables

The outcome variables were the same as those used in experiment 1 (described in Experiment 1 methods).

Covariates

As in experiment 1, age, gender, postcode IMD rank and time spent on the information and priming pages were captured to be used as covariates.

Exclusions

The exclusion criteria were the same as those used in experiment 1. Since both experiments 1 and 2 used Crowdflower as a recruitment platform, we used both IP addresses and postcode, age and gender combinations to check that participants in experiment 2 had not previously taken part in experiment 1. No repeat participants were identified. After exclusions, we were left with a sample of 195 participants.

Analysis

As in experiment 1, the effects of our covariates (age, gender, Index of Multiple Deprivation rank, and time spent on information and priming pages) on reported health intentions were assessed using a GLM. The covariates that had a significant effect on self-reported health intentions were then included in the main model. We also used custom contrasts to investigate whether there were differences between the uncontrollable and controllable treatments and between the long and short life treatments.

As in experiment 1, the effects of treatment on reward choice were tested using binary logistic regression. We first assessed which of the covariates had an effect on reward choice. None showed a significant effect, so we do not present an adjusted model for treatment effects. We ran a factorial treatment model, which contrasted the effects of the controllable treatments with the uncontrollable and the long life treatments with the short life ones.

Results

Descriptive statistics

There were 35 participants in the control treatment, 59 in the uncontrollable short life treatment, 44 in the uncontrollable long life treatment, 31 in the controllable short life treatment and 26 in the controllable long life treatment. There were 117 male participants and

78 female. Ages ranged from 18 to 73 years. Time spent on the information page ranged from 1-1402 seconds, with a mean of 102 seconds. Time spent on the priming pages ranged from 0-448 seconds, with a mean of 19 seconds. IMD ranks ranged from 1 to 31722 (of a possible 1-32482) with a median of 12555.

There was no significant difference in the ages of the participants across treatments ($F_{4, 190}$=1.20, p=0.31). There was no difference between treatments in the time spent on the information page ($F_{4, 184}$=0.69, p=0.60) or the priming page ($F_{4, 186}$=1.78, p=0.13). There was also no significant difference in the IMD rank of participants' postcodes across the treatments ($F_{4, 170}$=0.99, p=0.42). The distribution of the sexes of the participants was not significantly different across treatments (Fisher's exact, p=0.13).

Main results

In our covariates only model, there was an effect of sex on self-reported health intentions. Specifically, there was an effect of sex on intention to exercise (table 4), with males having a greater intention to exercise than females (male mean = 70.34, s.e. = 2.97; female mean = 58.13, s.e. = 3.50). Thus, sex was included in the main model. However, as in experiment 1, there was no effect of treatment on self-reported health intentions (table 4, table 5). There were also no significant differences in reported health intentions when we compared controllable with uncontrollable or long life with short life conditions using custom contrasts (table 6).

None of the covariates in the covariates only model had an effect on choice of fruit as a reward (table 7). Thus, no covariates were included in the main model. There was an effect of treatment on reward choice. Participants in the controllable treatments were more likely to choose fruit than participants in the uncontrollable treatments, or in the control (table 7, figure 2). However, there was no difference in food choice between the short and long life primes (table 7, figure 2). That is, there was an effect of the controllability of the mortality risk that was primed. The effect was of a similar magnitude to that seen in experiment 1. In the control treatment, 55% (n=18) chose fruit. In the uncontrollable treatments 51% and 51% (uncontrollable long life, n=21 and uncontrollable short life, n=29) of participants chose fruit. In the controllable treatments, 71 and 75% (controllable long life, n=15, controllable short life, n=20) of the participants choose fruit.

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Table 2. GLM results for the effect of covariates on health intentions (model 1) and the adjusted model for treatment plus sex, which had a significant effect in the first model (model 2).

Model 1: Covariates only	F	p	η_p^2
Age	2.14	0.079	0.06
Sex	3.90	0.005	0.11
IMD rank	2.12	0.082	0.06
Time on info page	0.38	0.825	0.01
Time on priming page	0.49	0.743	0.02

df=4, error=126, p = significance (*p≤0.05),

Model 2: Model for treatment effect	F	p	η_p^2	df	df error
Treatment	1.47	0.223	0.09	16	588
Sex	5.65	0.000	0.14	4	144

p = significance (*p≤0.05),

500 Table 3. Means and standard deviations for self-reported health intentions in experiment 2.

Self-reported intentions	Treatment	Mean	Standard deviation
Effort in looking after health	Control	67.24	24.136
	Uncontrollable long life	67.63	21.91
	Uncontrollable short life	62.53	21.567
	Controllable long life	65.4	28.397
	Controllable short life	60.26	26.291
Intention to eat 5 portions of fruit and veg per day	Control	50.84	31.126
	Uncontrollable long life	60.94	27.667
	Uncontrollable short life	52.4	29.199
	Controllable long life	67.73	25.877
	Controllable short life	57.17	31.96
Intention to exercise three times in coming week	Control	60.6	33.985
	Uncontrollable long life	69.13	29.921
	Uncontrollable short life	66.53	30.758
	Controllable long life	57.4	38.939
	Controllable short life	62.52	31.409
Intended units of alcohol intake in coming week	Control	6.64	9.836
	Uncontrollable long life	6.88	7.749
	Uncontrollable short life	5.55	9.816
	Controllable long life	3.07	3.9
	Controllable short life	3.13	5.833

501 Table 6. Results of custom contrasts between controllable and uncontrollable, and short and long life treatments for self-reported health
502 intentions.

Custom contrast of controllable versus uncontrollable conditions	Sum of Squares	Mean Square	F	p
Effort in looking after health	101.41	101.41	0.18	0.672
Intention to eat 5 portions of fruit and veg per day	26.53	26.53	0.03	0.861
Intention to exercise three times over the coming week	1022.65	1022.65	0.99	0.322
Intended units of alcohol intake over the coming week	63.45	63.45	0.68	0.410
Custom contrast of long life versus short life conditions	**Sum of Squares**	**Mean Square**	**F**	**p**
Effort in looking after health	1266.21	1266.21	2.25	0.135
Intention to eat 5 portions of fruit and veg per day	1528.08	1528.08	1.77	0.185
Intention to exercise three times over the coming week	323.19	323.19	0.31	0.577
Intended units of alcohol intake over the coming week	64.55	64.55	0.70	0.406

503 df=1, p = significance (*p≤0.05).

Table 7. Binary logistic regression results showing the effect of covariates and of treatments on the odds of selecting fruit over chocolate.

Model 1: Covariates only	Odds ratio	Lower CI	Upper CI	p
Sex[†]	1.02	0.51	2.04	0.964
Age	1.03	0.99	1.06	0.135
Neighbourhood deprivation score	1.00	1.00	1.00	0.865
Time spent on information page	1.03	1.00	1.06	0.078
Time spent on priming page	1.00	0.99	1.01	0.534

Model 2: Model for treatment effect	Odds ratio	Lower CI	Upper CI	p
Controllable vs. uncontrollable	2.585	1.22	5.47	0.013*
Long life vs. short life	1.062	0.54	2.10	0.862

CI = 95% confidence interval, p = significance (*p≤0.05)

[†]The reference category is female.

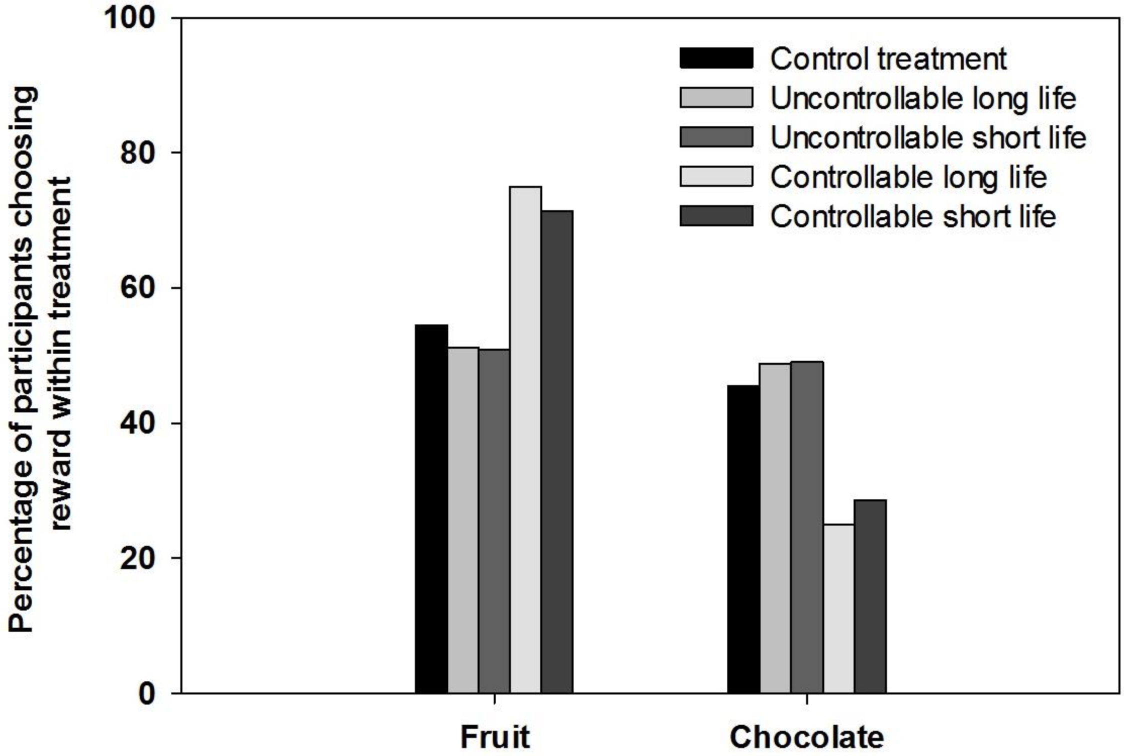

Figure 2. The percentage of participants who chose fruit or chocolate rewards in response to controllable or uncontrollable, long or short life primes and the control condition of experiment 2.

Experiment 2 discussion

Experiment 2 parsed the effects of controllability from those of long and short life primes. The results showed that people were more likely to choose fruit over chocolate in the controllable, but not the uncontrollable treatments, regardless of whether they were told they were likely to have longer, or shorter life spans. The result in the experimental control treatment looked similar to those in the uncontrollable treatments (figure 2). This suggests that, at least for the sample of participants in experiment 2, the "default" reward preference was akin to the preference under conditions of uncontrollable mortality.

As in experiment 1, there was no effect of treatment on self-reported intentions, but there was an effect on reward choice. As discussed for experiment 1, this suggests an implicit or automatic decision process, rather than an explicit or reasoned one.

The results of experiment 2 helped us to rule out the possibility that the effect seen in experiment 1 was a normative one. In experiment 1, in the uncontrollable short life condition, the health behaviour of others was not mentioned. Yet, in the controllable long life condition, it was the health behaviour of others in the participants' demographic that was suggested to be the cause of their longevity. This might have elicited a social norms effect by suggesting that others of the same demographic were living healthy lives. Norms are thought to play a role in influencing health behaviour (Ball et al., 2010; Wood et al., 2012). Thus, it was important that we use experiment 2 to rule out the possibility of a normative effect. In experiment 2, in the controllable mortality condition, the norm was that people were dying younger because of poor health habits. The selection of fruit still increased in this condition, relative to the uncontrollable and control conditions, suggesting that the result of experiment 1 was not due to a normative effect.

Although experiment 2 parsed the effects of controllability from those of long and short life primes and also ruled out the possibility of a normative effect, another potential confound remained: There may have been a demand effect, because both experiments 1 and 2 were explicitly health related. In order to rule this out, we ran a third experiment in the field.

Experiment 3: Replication of the controllability priming effect in a surreptitious field experiment

This field experiment built upon our online experiments. We ran it as a surreptitious experiment in order to remove any demand characteristics. This also allowed us to test whether the effect could be seen in a real-world setting. The study took place in a busy shopping centre in the Tyne and Wear area. Participants were told that they were taking part in a public opinion survey run by Newcastle University, in exchange for being entered into a prize draw. Rather than our participants giving their details and receiving feedback about the average person of their demographic, we primed them using a question on the polling card. The questions suggested that people in Tyne and Wear are living longer, either due to uncontrollable causes, or due to controllable ones. That is, the primes were both long life primes, but the controllability of the causes was different. We hypothesised that, as in experiments 1 and 2, participants in the controllable treatment would choose fruit more often than participants in the uncontrollable treatment.

Methods

Recruitment

Participants were recruited at a large shopping centre in the Tyne and Wear area. Data were collected over two weekends in November 2013, with the first run of data collection running from Friday to Sunday and the second on a Saturday and Sunday (five days in total). The experimenter stood next to a pop-up stand with two large polling boxes and the prize draw cards. The pop-up stand and the cards gave instructions for participating. The experimenter also explained the entry procedure verbally. Participants were asked to complete a polling card with their name, address and date of birth. They were then asked to circle their answer to a multiple choice question (the prime – see details below) and to place their card into a polling box. The main incentive to participate was the chance of winning one of three £100 shopping vouchers. Participants were told that they would all be entered for the chance to win this main prize. As "bonus" prizes there were ten organic fruit boxes and ten chocolate collection boxes to be won. Participants had to indicate which of these they would prefer to win, by posting their card into the relevant polling box. The primes were presented alternately at the polling stand in two hour slots, which were counterbalanced across the 50 hours during which data was collected.

Covariates

Age was calculated from the date of birth entered on the polling cards. As in the two online experiments, postcode IMD was used as a measure of socioeconomic status.

Primes

We used two primes, both longevity-focussed, but differing in their controllability. In the uncontrollable condition, participants were asked to answer the following multiple choice question: "Recent statistics show that people in Tyne and Wear are living longer now than they were in the year 2000. Why do you think this is? A) Because there are fewer traffic accidents. B) Because there is less violent crime. C) Both: there are fewer traffic accidents and less violent crime." (An electronic copy of the prize draw card can be seen in the online supporting materials.) This question was designed to imply that the most important local sources of mortality were things beyond individual control. In the controllable condition, participants were asked to answer a different multiple choice question: "Recent statistics show that people in Tyne and Wear are living longer now than they were in the year 2000. Why do you think this is? A) Because people have more control over the kind of healthcare they receive. B) Because people are looking after themselves better. C) Both: people have more control over their care and are looking after themselves better." This question was intended to imply that the most important local sources of mortality were things within individual control.

Outcome variable

The outcome variable was our participants' choice of bonus prize. As in experiments 1 and 2, this could be either an organic fruit box worth £11 or a chocolate collection box worth £11.

Analysis

The effects of treatment on reward choice were evaluated using binary logistic regression. In model 1 we assessed the effects of the covariates, age and IMD rank. Since no effects were found, these covariates were not included in model 2, which assessed the treatment effect.

Results

Descriptive statistics

There were 121 participants in the uncontrollable treatment, and 116 in the controllable treatment. Ages ranged from 15 to 87 years. IMD ranks ranged from 93 to 31247 (of a possible 1-32482) with a median of 9944. Thus, the participants in this field experiment lived, on average, in more deprived neighbourhoods than those who took part in the experiments 1 and 2.

There was no significant difference in the ages of the participants across treatments ($t_{229} = -0.78$, $p = 0.43$). There was also no significant difference in the IMD rank of participants' postcodes across the treatments ($t_{227} = -0.10$, $p = 0.92$).

Main results

Neither age, nor neighbourhood IMD rank had any effect in the covariates only model. Thus, they were not included in the main model (table 8). There appeared to be an effect of treatment on tendency to choose fruit, rather than chocolate, as a reward. Of the participants in the uncontrollable treatment, 22% (n=27) chose fruit as a reward. In the controllable treatment, 34% (n=39) of participants chose fruit, a 54% relative increase (figure 3). However, the result of the binary logistic regression was marginally non-significant (p=0.054, table 8).

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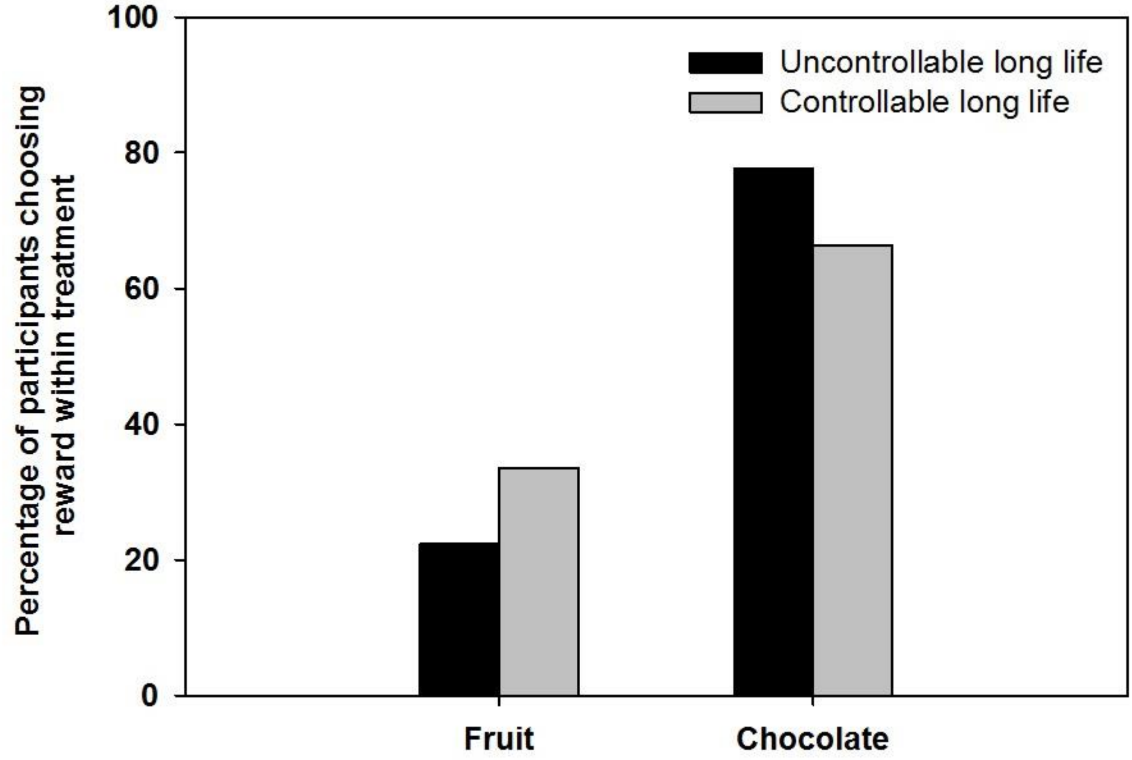

Figure 3. Experiment 3 results. The percentage of participants who chose fruit or chocolate rewards in response to controllable or uncontrollable long life primes.

Table 4. Adjusted model showing the odds of selecting fruit over chocolate by experimental treatment with the uncontrollable treatment as the reference category.

Model 1 – covariates only	**Odds ratio**	**Lower CI**	**Upper CI**	**p**
Age	1.01	1.00	1.03	0.182
Neighbourhood deprivation score	1.00	1.00	1.00	0.970

Model 2 – model for treatment effect	**Odds ratio**	**Lower CI**	**Upper CI**	**p**
Treatment	1.76	0.99	3.14	0.054*

CI = 95% confidence interval, p = significance (*p≤0.05)

Experiment 3 discussion

Our field experiment replicated the pattern seen in our online experiments, although the effect was marginally non-significant. This may have been due to a lack of power to detect the effect, which was smaller than in the other studies (odds ratios: experiment 1 = 2.93; experiment 2 = 2.59; experiment 3 = 1.76). However, given that qualitatively similar results were found for all three studies, we can be more confident that the statistically marginal result of experiment 3 represents a real effect (Moonesinghe, Khoury, & Janssens, 2007).

There were some ways in which the effects seen in experiments 1 and 2 may have been diluted in experiment 3. The uncontrolled nature of the experimental environment allowed unpredicted participant behaviours. For example, some participants (n=13) filled out the question card and then handed the card to their children and allowed them to choose the prize (invariably these children chose chocolate). Once the cards were in the polling boxes, they were impossible to trace, so these participants could not be identified or excluded from the analysis. If parents had not allowed their children to choose the prizes, the effect might have been larger, but unfortunately it is not possible to confirm this.

Similarly, the fact that the experiment took place in a large shopping centre during November may have influenced the results. Many participants were at the centre to do their Christmas shopping. When selecting chocolate, some participants (number not noted) made comments such as, "I would choose fruit for myself, but chocolate will make a good Christmas present for someone." Thus, the effect might have been diluted in this experiment, but not in the online experiments, which were carried out earlier in the year.

Finally, the participants in the field experiment were, on average, from more deprived neighbourhoods than those who took part in the online studies. This may have biased the response, since we expect people from more deprived neighbourhoods to be more frequently exposed to cues to uncontrollable mortality, than those from more affluent neighbourhoods (Lantz et al., 1998; Lawlor, Frankel, Shaw, Ebrahim, & Smith, 2003; Nettle, 2010). That is, our prime could be expected to have a less pronounced effect, when its message conflicts with participants' personal experiences.

There was one other minor issue with the field experiment (3). The experimenter was not blind to the treatments. However, the online experiments (1 and 2) were double-blind, since the treatments were randomly allocated by Qualtrics, and, as we have seen, the results were comparable.

The fact that the observed effect was replicable in a surreptitious experiment goes some way towards ruling out the possibility of a demand effect. Participants were not aware that they were taking part in an experiment, or that it was related to health behaviour.

Finally, the result of experiment 3 demonstrates that the effect seen in the online experiments can be translated into a real world setting. This suggests that enhancing people's sense of control over sources of mortality and ill health could be an effective way of improving real world health behaviours.

Overall discussion

The results of our online and field experiments lend support to the Uncontrollable Mortality Risk Hypothesis. They suggest that perceptions about the controllability of mortality risk may have an important influence on health behaviours. Experiment 1 was the first, to our knowledge, to demonstrate an effect of uncontrollable mortality priming on an unconnected health-related decision. Experiment 2 was the first to separate out the effects of uncontrollable and controllable mortality primes on a health-related decision. Experiment 3 replicated the main effect of the first two experiments in a surreptitious experiment, suggesting that the effect seen in the first two experiments was not due to any demand characteristic.

While our experimental treatments affected participant behaviour, there was no effect on our participants' self-reported intentions (experiments 1 and 2). This implies that the decision to take fruit as a reward may have involved implicit and automatic processes – even when health was made salient. That is, our results suggest that people do not consciously calculate their degree of control over their mortality risk and then decide whether to choose a healthy or unhealthy reward. They suggest that the process is automatic, occurring without explicit reasoning (see Evans 2003). Previous research shows that a number of health behaviours seem to involve implicit processes and there have been calls to examine the role of implicit processes in health behaviour more closely (Gibbons et al., 2009; Sheeran et al., 2013). Our findings reinforce this call.

In our introduction, we outlined theoretical perspectives that shared features of the Uncontrollable Mortality Risk Hypothesis, which our experiments were designed to test. Although our experiments were not designed to test the predictions of the alternative hypotheses outlined in our introduction, we can still discuss our results in their context.

Our results may help to shed light on the associations between Health Locus of Control and health behaviour (Reitzel et al., 2013; Wardle & Steptoe, 2003). When people feel that they have low control in general (external control beliefs), they are likely to believe that they have little control over their mortality risk. If so, investing effort, time or money in controlling what little they can, would have a lower payoff than for others who feel that they have more control over their mortality risk (internal control beliefs).

The Extended Parallel Process Model states that messages depicting threats will be acted upon to the extent that the available solutions are seen to be effective. It proposes that a threat must have severe consequences in order to gain people's attention and motivate them to act. In addition to this, the recommended action must be perceived to be highly effective for this motivation to be translated into behavioural change. However, our result suggests that a threat does not need to be overt for an effect to be seen. In our experiments, there were no dramatic fear appeals. We simply mentioned that people of the participant's demographic were either living longer (or not) than average and manipulated the causes to be more or less controllable. In experiment 3, health was barely mentioned and no health advice was given. Nonetheless, we saw a switch to a healthier reward choice. This is likely to be because the choice was between two foods which are widely known to be healthy (fruit) and unhealthy (chocolate). No further health information was needed. This demonstrates that fear appeals may not be necessary to motivate behaviour change. In some cases, where the healthy choice is widely known to be so (e.g. to not smoke), recommended health actions may not be needed. It may be enough simply to reduce perceived (or better still, actual) uncontrollable mortality risks. Indeed, the fact that uncontrollable mortality risk alters the likely payoff of investing in health, could help to explain why interventions intended to improve health behaviours simply by giving information have been ineffective (e.g. Buck & Frosini 2012; Downs et al. 2013). Merely giving information could be insufficient to change motivation (Pepper & Nettle, 2014b; White, Adams, & Heywood, 2009), especially when the information given only pertains to risks already perceived as controllable and does nothing to reduce the severity of any uncontrollable risks perceived.

The fact that the effect of our primes seemed to be implicit and automatic goes against the predictions of the Terror Management Health Model. The Terror Management Health Model predicts that people should act in a health oriented way when explicitly primed, but not when the mortality salience is implicit (Goldenberg & Arndt, 2008). In addition, in the treatments where participants were told they would live longer than average, it could be reasoned that mortality is made more distant, rather than salient. However, we still saw an effect in these treatments, based on whether the causes of mortality were controllable, rather than upon whether premature mortality was emphasised.

More research on the effects of uncontrollable mortality risk is needed. If mortality controllability priming could be used increase motivation towards healthy behaviours, then it is important to test it in new populations and situations and to learn more about when it works. For example, our primes were effective in a situation where people were being offered a food reward free-of-charge. However, the situation may be different when people are paying for the food themselves. Furthermore, our reward options were binary (fruit versus chocolate). Results may be different if there is a range of options to choose from – especially if the options are less obviously healthy and unhealthy ones. Finally, the experiments we have run so far have only examined food choice. We do not currently know whether such primes can be used to influence other health-related decisions.

It is also important to learn more about perceptions of the controllability of common mortality risks. Knowing whether perceptions are accurate could help to guide decisions about whether and how they should be corrected. Understanding where perceptions come from could help policy makers to influence any sources of information which lead to misconceptions. For example, if media scare stories bias perceptions of uncontrollable mortality risk, then increasing awareness of this issue among journalists and calling for increased journalistic responsibility would be important.

The effect of controllability may go beyond health behaviour. It is possible that the controllability of mortality risk influences a range of behaviours involving trade-offs between costs and rewards in the present and those in the future. When the risk of death is high (and cannot be mitigated), the odds of being alive to receive future rewards are reduced. Thus, people who believe they have a high and uncontrollable risk of mortality should be less future-oriented than those who believe that they can control their mortality risk. There is some support for this idea in the existing literature. Differences in time perspective have been shown to be associated with a variety of health behaviours (Adams & Nettle, 2009; Adams &

White, 2009; Adams, 2009), and with differences in reproductive scheduling (Daly & Wilson, 2005; Kruger, Reischl, & Zimmerman, 2008; Pepper & Nettle, 2013). There is also evidence to suggest that differences in time perspective could be caused by exposure to signals of uncontrollable mortality. For example, future discounting has been found to be steeper in people who had experienced a larger number of recent bereavements (Pepper & Nettle, 2013) and in recent earthquake survivors, compared to controls (Li et al., 2012).

The results of our experiments support the idea that perceptions about the controllability of mortality risk may be an important factor influencing people's health-related decisions. This finding is congruent with other evidence about the importance of Health Locus of Control for health (Burker et al., 2005; Holt et al., 2000; Poortinga et al., 2008; Wardle & Steptoe, 2003; Williams-Piehota et al., 2004) and the influence of mortality priming on behaviour (Griskevicius, Delton, Robertson, & Tybur, 2011; Griskevicius, Tybur, Delton, & Robertson, 2011; Mathews & Sear, 2008). However, our Uncontrollable Mortality Risk Hypothesis is subtly different to other perspectives in the health literature and the results of our experiments suggest that the difference may be a crucial one.

Adjusting perceptions about the controllability of mortality risk could become an important tool in health interventions. Our findings also emphasise the importance of tackling sources of mortality which are beyond individual control. Making neighbourhoods and work places safer would have the primary benefit of reducing mortality risks beyond individual control, but could also lead to improved health behaviours.

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