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

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18
19 **Abstract**

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

38 Introduction

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

47 A substantial research effort has been made towards improving the efficacy of health
48 messages to promote behaviour change. One of the key ideas to emerge from this research has
49 been that perceived control and efficacy should influence health behaviour. Health Locus of
50 Control describes the extent to which a person believes that their health is determined by the
51 actions of individuals, rather than by chance, and whether the locus of that control is internal
52 (a result of their own actions) or external (resulting from the actions of others). Prior findings
53 suggest that Health Locus of Control is important both for health outcomes (e.g. Burker,
54 Evon, Galanko, & Egan, 2005; Poortinga, Dunstan, & Fone, 2008) and for health behaviours
55 (Reitzel et al., 2013; Wardle & Steptoe, 2003).

56 Other research themes focus on the effects of mortality salience and perceived threat on health
57 behaviour. Terror Management Theory (Greenberg, Pyszczynski, & Solomon, 1986) proposes
58 that people have a fear of death, which causes anxiety or terror when they are made aware of
59 their vulnerability. It suggests that, when people are made to think about their mortality (a
60 condition known as mortality salience) they will attempt to buffer their anxieties and to
61 suppress conscious thoughts of death. Goldenberg and Arndt (2008) extended Terror
62 Management Theory to create the Terror Management Health Model for behavioural health
63 promotion. They proposed that conscious thoughts about death (as elicited by many fear
64 appeals) would trigger behavioural responses (in this case, health improving behaviour) aimed
65 at reducing the threat, and thus the accompanying fear of death. They proposed that when
66 thoughts about death are unconscious, people should act not to reduce the threat to their life,
67 but to direct their efforts to maintaining a sense of meaning and self-esteem.

68 The fear appeal literature combines elements of control with those of threat. (Fear appeals are
69 messages intended to persuade people to change their behaviour by inducing fear regarding
70 health threats.) Theoretical frameworks used in the fear appeal literature (e.g. Extended
71 Parallel Process Models and Protection Motivation Theory - comprehensively reviewed by
72 Witte & Allen, 2000) emphasise the importance of efficacy in eliciting behaviour change. In
73 general, these theories suggest that if there is a strong threat to health and a highly effective
74 solution is available, then people will act to use that solution. However, if messages offer
75 threats without suggesting that there are effective solutions, behaviour change will not occur.
76 That is, these models state that threat serves to motivate people towards possible solutions,
77 but that if people do not feel that the solutions will be effective, they are unlikely to act (Goei
78 et al., 2010; Lewis, Watson, & White, 2013; Witte & Allen, 2000).

79 *The Uncontrollable Mortality Risk Hypothesis*

80 Similarly, our previously presented theoretical model (Nettle, 2010) combined elements of
81 control and threat to life. It suggested that differences in health behaviour could be explained
82 by differential exposure to uncontrollable mortality risk: The Uncontrollable Mortality Risk
83 Hypothesis. The hypothesis suggests that people who are likely to be killed by factors beyond
84 their control should be less motivated to invest effort in looking after their future health. This
85 makes intuitive sense when you consider that people who are exposed to high uncontrollable
86 mortality risk are less likely to survive to reap the rewards of their healthy behaviour, which
87 are likely to be garnered in the far future. To give a caricatured example, there is little point in
88 investing in a healthier diet when you feel you could be killed by an erupting volcano at any
89 moment. We previously tested predictions from this hypothesis using survey data (Pepper &
90 Nettle, 2014a). We found that people who perceived a higher portion of their personal
91 mortality risk to be beyond their control were less motivated to invest effort in looking after
92 their health.

93 Our hypothesis differs from theories in the fear appeal literature, since these focus on the
94 controllability of the specific aspects of health which are being communicated and not on the
95 controllability of mortality risk more generally. For example, they predict that the belief that
96 you can control your risk of diabetes by modifying your diet will affect your motivation to eat
97 healthily. By comparison, our hypothesis predicts that perceived control over mortality risk
98 should alter motivation towards healthy behaviour— even when the healthy behaviour is not a
99 recommended response to that risk. For example, if you believe you are unable to control
100 your risk of falling victim to a volcanic eruption, you should be less inclined to eat healthily.
101 A healthy diet is not a recommended response to reduce the threat posed by a volcano and yet,
102 we should expect the controllability of one risk to influence the payoff to investing in
103 mitigating the other.

104 Our hypothesis also takes a different perspective to Health Locus of Control studies, which
105 tend to implicitly assume that Health Locus of Control is a stable individual trait, rather than a
106 flexible response to information from the environment. By comparison, behaviour as a
107 response to environmental cues is a key assumption of the Uncontrollable Mortality Risk
108 Hypothesis. Finally, while Terror Management Theory emphasises the importance of
109 mortality per se, our hypothesis suggests that it is the controllability of the mortality risk
110 which should be important.

111 In summary, a range of theories emphasize the importance of mortality salience and control in
112 the behavioural responses to health messages. Our Uncontrollable Mortality Risk Hypothesis
113 specifically predicts that cueing mortality risk per se will not affect health behaviours, but
114 rather, that it will be the controllability of the mortality risk that influences the decision to
115 behave healthily.

116 Here, we present three experiments testing this prediction. The first was a test of whether
117 mortality primes can be used to influence a health-related decision – the choice between a
118 healthy food reward and an unhealthy one. The second experiment used the same method but
119 with primes that separated out the effects of controllability from those of mortality priming.
120 That is, we tested whether there is an effect of mortality salience per se, or whether it is the

121 controllability of mortality risk which is important. The third study aimed to rule out the
122 possibility that the results of the first two studies were due to demand characteristics; the
123 participants did not know that they were taking part in an experiment and health was never
124 explicitly mentioned.

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

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

136 **Methods, materials and analysis**

137 All of our experiments (1, 2 & 3) received ethical approval from the Newcastle University
138 Faculty of Medical Sciences ethics committee. Participants for experiments 1 and 2 were
139 recruited using the Crowdfunder crowdsourcing platform (<http://crowdfunder.com>).
140 Participants followed a link to the experiment, which was generated using Qualtrics (version
141 2013, <http://www.qualtrics.com>). Participants were presented with an information screen
142 which contained statements about ethics and privacy and provided contact details for the
143 experimenters. The introduction to the study explained that it was about life expectancy
144 differences within the UK (see questionnaire in supplement). This included a link to a news
145 article about Public Health England's Longer Lives website (<http://longerlives.phe.org.uk/>),
146 which provides a map of the regions of England, ranked by rates of premature mortality.
147 Since experiment 1 was launched on July 2nd, 2013, less than a month after this map had
148 been headline news, it made a timely cover story for the experiment. Participants completed
149 an electronic consent form.

150 We needed to ensure that our participants were from the UK, because the primes were based
151 on UK postcode statistics. Thus, participants were filtered through a location check using
152 their Internet Protocol address (IP address) and an explicit question about whether they were
153 resident in the UK. Participant location information (based on IP address) and reported
154 postcode were triangulated with self-reported UK residency to assess the reliability of the
155 data. Consistency of location reporting was used as an inclusion criterion (see supplement for
156 full details).

157 Participants moved on to a screen which asked for their age, gender and current postcode.
158 After giving this information, all participants were presented with a "loading" animation,
159 timed to auto-progress after 12 seconds. The message under the animation read, "Thanks for
160 submitting your information. It may take a while to match it to health data for people of your
161 age and gender in your postcode area. Please wait a few moments." This loading screen was

162 designed to create the impression that the demographic information given by participants was
163 being used to look up real information about life expectancies for people who shared their
164 characteristics. Participants then were randomly allocated to one of the primes.

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

169 *Uncontrollable short life prime*

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

176 *Controllable long life prime*

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

182 *Outcome variables*

183 Following the priming screen, participants moved on to the health behaviour questions. They
184 were asked to answer some simple scale-based (0-100) questions about their intended health
185 behaviour over the coming week (see supplement for full questionnaire). We refer to the
186 answers to these as self-reported health intentions. The first was a general question, about the
187 effort the participant intended to put into looking after their health. The second question was
188 about whether the participant intended to eat the recommended 5 portions of fruit and
189 vegetables a day. The third question was about whether the participant would do a
190 recommended level of exercise. The final question was about how much alcohol the
191 participant intended to consume. After the questionnaire was completed, participants were
192 moved onto a screen, which was ostensibly separate to the questionnaire. They were thanked
193 for taking part in the study and told that, as an extra thank you for taking part, they could opt
194 to be entered into a prize draw. They were asked to select the prize which they would prefer to
195 win. The options were an organic fruit box worth £11, or chocolate collection box worth
196 £11. This was our behavioural outcome measure – their choice between a healthier prize
197 (fruit) and an unhealthy one (chocolate). After choosing their reward, participants moved on
198 to a debrief screen, which made it clear that the feedback given about life expectancies in their
199 area had been false (debrief text is included in the questionnaire shown in the supplement).

200 *Covariates*

201 The age and gender that the participants entered at the beginning of the experiment were used
202 as covariates. Their postcode was used to generate a deprivation score for their current

203 residential neighbourhood. This was done using the Office for National Statistics' Indices of
204 Multiple Deprivation (Mclennan, Barnes, Noble, Davies, & Garratt, 2011). The IMD identify
205 the most deprived areas of the country, by combining a range of economic and social
206 indicators into a single score. Areas can be identified by their IMD rank, which is considered
207 to be a useful objective measure of an individual resident's socioeconomic status (Danesh et
208 al., 1999). We used the statistics for the lower layer super output areas – LSOAs. Finally, we
209 used the lengths of time that the participant spent on the participant information screen and
210 the priming screen as covariates. We did this because participants who spent more time
211 reading the cover story and feedback information may have believed the cover story to a
212 greater extent and thus may have been more strongly primed.

213 *Analysis*

214 All analysis was carried out in SPSS version 19. We excluded data from participants whose
215 self-reported location was not consistent with our location checks (see supplement). The
216 effects of our covariates on reported health intentions were assessed using a GLM. This was
217 done so that any covariates that had a significant effect on self-reported health intentions
218 could be controlled for in our main statistical model.

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

223 **Results**

224 *Descriptive statistics*

225 35 participants were randomly allocated to the controllable long life treatment and 37 to the
226 uncontrollable short life treatment. 39 participants were male and 33 were female. Ages
227 ranged from 19 to 69 years. Time spent on the information page ranged from 0-199 seconds,
228 with a mean of 20 seconds. Time spent on the priming pages ranged from 9-138 seconds, with
229 a mean of 22 seconds. Participants' neighbourhood IMD scores ranged from 3.64 to 65.40 (of
230 a possible 0.53-87.80) with a mean of 23.88.

231 There was no significant difference in the ages of the participants across treatments ($t_{70}=-0.50$,
232 $p=0.62$). There was also no difference between treatments in the time spent on the information
233 page ($t_{69}=0.70$, $p=0.48$) or the priming page ($t_{61}=1.09$, $p=0.28$). The IMD score of
234 participants' postcodes did not vary across treatments ($t_{61}=-0.59$, $p=0.558$). There was no
235 difference in the distribution of the sexes of participants across treatments (Fisher's exact,
236 $p=0.35$).

237 *Main results*

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

241 None of the covariates showed an effect on choice of fruit, rather than chocolate, as a reward.
242 However, there was an effect of treatment on reward choice (table 3). Of the participants in

243 the uncontrollable short life treatment, 31% (n=10) chose fruit as a reward. In the controllable
 244 long life treatment, 57% (n=20) of the participants chose fruit (figure 1, table 3).

245

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

249

Model 1: Covariates only	F	p	η_p^2
Age	1.44	0.238	0.115
Sex[†]	0.72	0.585	0.061
IMD score	0.37	0.828	0.033
Time on info page	1.65	0.178	0.131
Time on priming page	1.58	0.196	0.126

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

251

252

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

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

254 Table 2. Means and standard deviations for self-reported health intentions in the controllable long life prime and uncontrollable short life
 255 treatments.

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)

256

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

260

Model 1: Covariates only	Odds ratio (lower CI –upper CI)	p
Sex[†]	1.64 (0.54-5.01)	0.383
Age	1.01 (0.97-1.06)	0.653
Neighbourhood deprivation score	1.00 (0.96-1.03)	0.896
Time spent on information page	1.00 (0.97-1.04)	0.790
Time spent on priming page	0.96 (0.91-1.01)	0.128
<hr/>		
Model 2: Model for treatment effect	Odds ratio(lower CI –upper CI)	p
Treatment	2.93 (1.08-8.00)	0.036*

261

262

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

263

[†]The reference category is female.

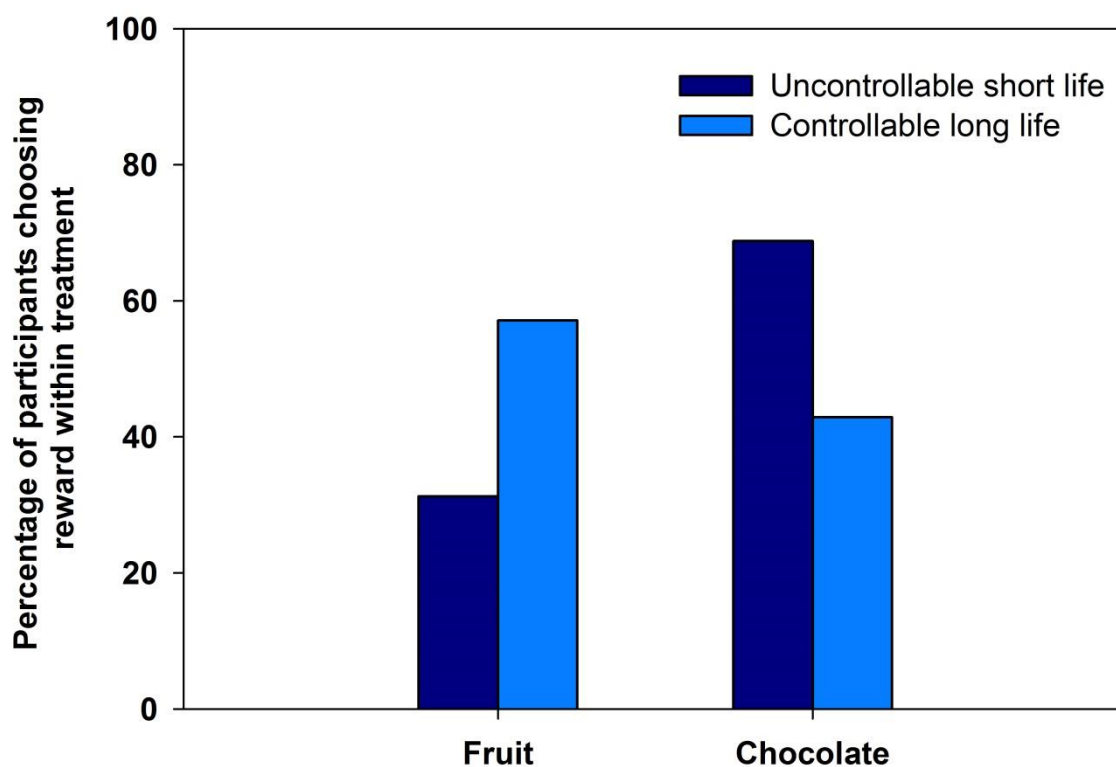


Figure 1. The percentage of participants who chose fruit or chocolate rewards after exposure to either a controllable long life prime or uncontrollable short life prime.

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 prior 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

287 the norms described in the primes. It was important to rule out this potential confound. Thus,
288 in experiment 2, we added a control treatment, and designed new primes which separated the
289 effect of mortality salience from that of controllability. Since the norms contained in the two
290 controllable treatments were opposing, this also addressed the potential of a confounding
291 normative effect.

292 **Experiment 2: Separating the effects of mortality priming from those of controllability** 293 **priming**

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

307 **Methods and materials**

308 As in experiment 1, participants were recruited using Crowdfunder and followed a link to a
309 Qualtrics-based experiment. The experiment was launched on August 14, 2013. The
310 participant information, consent form and location check screens were the same as those used
311 in experiment 1 (see supplement). Again, participants entered their demographic information,
312 saw a “loading” animation, and then were randomly allocated to one of the treatments. While
313 the primes in experiment 1 were personalised to age, gender and postcode, experiment 2
314 primes were only personalised by postcode. In addition, the reference frames were changed.
315 We did this in order to test a form of words which would not involve deceit, because in our
316 later field study (experiment 3, see below), there would be no opportunity to debrief
317 participants. This meant shifting the reference frame (either the same residential area in the
318 year 2000, or other UK regions in the present), so that deceit was not necessary (because it is
319 true that people in Tyne & Wear are living longer than they were in the year 2000, but also,
320 not as long as others in the UK – see experiment 3).

321 *Control condition*

322 In the control condition, there was no feedback after the participant entered their information.
323 They simply waited for 12 seconds at the loading screen and then saw the message, “Thanks
324 for submitting your basic information. Please answer the following questions about your
325 health.”
326

327 *Uncontrollable short life prime*

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

336 *Uncontrollable long life prime*

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

343 *Controllable short life prime*

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

351 *Controllable long life prime*

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

360 *Outcome variables*

361 The outcome variables were the same as those used in experiment 1.

362 *Covariates*

363 As in experiment 1, age, gender, postcode IMD score and time spent on the information and
364 priming pages were used as covariates.

365 *Exclusions*

366 The exclusion criteria were the same as those used in experiment 1 (see supplement for
367 details).

368 *Analysis*

369 As in experiment 1, the effects of our covariates on reported health intentions were assessed
370 using a GLM, so that any that had a significant effect could be included in the main model.

371 We also used custom contrasts to investigate whether there were differences between the
372 uncontrollable and controllable treatments and between the long and short life treatments.

373 As in experiment 1, the effects of treatment on reward choice were tested using binary logistic
374 regression. Again, we first assessed whether any covariates had an effect on reward choice, so
375 that they could be included in our model. We ran a factorial treatment model, which
376 contrasted the effects of the controllable treatments with the uncontrollable and the long life
377 treatments with the short life ones.

378 **Results**

379 *Descriptive statistics*

380 There were 35 participants in the control treatment, 59 in the uncontrollable short life
381 treatment, 44 in the uncontrollable long life treatment, 31 in the controllable short life
382 treatment and 26 in the controllable long life treatment. There were 117 male participants and
383 78 female. Ages ranged from 18 to 73 years. Time spent on the information page ranged from
384 1-1402 seconds, with a mean of 102 seconds. Time spent on the priming pages ranged from 0-
385 448 seconds, with a mean of 19 seconds. IMD scores ranged from 3.15 to 87.80 (of a possible
386 0.53-87.80) with a mean of 25.84.

387 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
388 information page ($F_{4, 184}=0.69$, $p=0.60$) or the priming page ($F_{4, 186}=1.78$, $p=0.13$). There was
389 also no significant difference in the IMD score of participants' postcodes across the
390 treatments ($F_{4, 170}=0.99$, $p=0.414$). The distribution of the sexes of the participants was not
391 significantly different across treatments (Fisher's exact, $p=0.13$).
392

393 *Main results*

394 In our covariates only model, there was an effect of sex on self-reported health intentions.
395 Specifically, there was an effect of sex on intention to exercise (table 4), with males having a
396 greater intention to exercise than females (male mean = 70.34, s.e. = 2.97; female mean =
397 58.13, s.e. = 3.50). Thus, sex was included in the main model. However, as in experiment 1,
398 there was no effect of treatment on self-reported health intentions (table 4, table 5). There
399 were also no significant differences in reported health intentions when we compared
400 controllable with uncontrollable or long life with short life conditions using custom contrasts
401 (table 6).

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

411 In the controllable treatments, 71 and 75% (controllable long life, n=15, controllable short
 412 life, n=20) of the participants choose fruit.

413

414 Table 4. GLM results for the effect of covariates on health intentions (model 1) and the
 415 adjusted model for treatment plus sex, which had a significant effect in the first model (model
 416 2).

Model 1: Covariates only	F	p	η_p^2
Age	1.05	0.384	0.040
Sex	3.30	0.014*	0.116
IMD score	1.22	0.305	0.046
Time on info page	0.35	0.844	0.014
Time on priming page	0.50	0.735	0.019

df=4, error=101, p = significance (*p≤0.05)

Model 2: Model for treatment effect	F	p	η_p^2	df	df error
Treatment	1.01	0.437	0.032	12	363
Sex	4.92	0.001*	0.142	4	119

p = significance (*p≤0.05)

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423 Table 1. 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 (24.14)
	Uncontrollable long life	67.63 (21.91)
	Uncontrollable short life	62.53 (21.57)
	Controllable long life	65.4 (28.40)
	Controllable short life	60.26 (26.29)
Intention to eat 5 portions of fruit and veg per day	Control	50.84 (31.13)
	Uncontrollable long life	60.94 (27.67)
	Uncontrollable short life	52.4 (29.20)
	Controllable long life	67.73 (25.88)
	Controllable short life	57.17 (31.96)
Intention to exercise three times over the coming week	Control	60.6 (33.99)
	Uncontrollable long life	69.13 (29.92)
	Uncontrollable short life	66.53 (30.76)
	Controllable long life	57.40 (38.94)
	Controllable short life	62.52 (31.41)
Intended units of alcohol intake over the coming week	Control	6.64 (9.84)
	Uncontrollable long life	6.88 (7.75)
	Uncontrollable short life	5.55 (9.82)
	Controllable long life	3.07 (3.90)
	Controllable short life	3.13 (5.83)

424 Table 6. Results of custom contrasts between controllable and uncontrollable, and short and
 425 long life treatments for self-reported health intentions.
 426

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

427 df=1, p = significance (*p≤0.05).

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

Model 1: Covariates only	Odds ratio (lower CI –upper CI)	p
Sex[†]	0.68 (0.30-1.50)	0.340
Age	1.03 (0.99-1.07)	0.125
Neighbourhood deprivation score	1.00 (0.98-1.03)	0.978
Time spent on information page	1.03 (0.99-1.06)	0.134
Time spent on priming page	1.00 (0.99-1.01)	0.470
Model 2: Model for treatment effect	Odds ratio (lower CI –upper CI)	p
Controllable vs. uncontrollable	2.59 (1.22-5.47)	0.013*
Long life vs. short life	1.06 (0.54-2.10)	0.862

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

[†]The reference category is female.

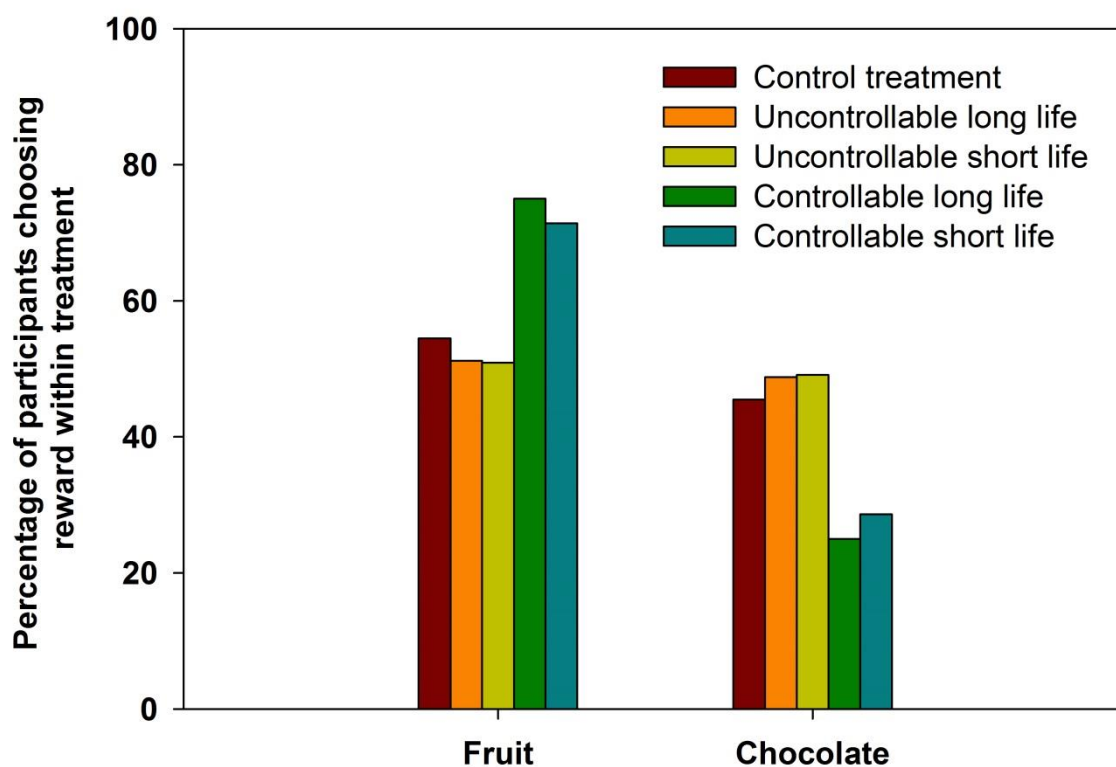


Figure 2. The percentage of participants who chose fruit or chocolate rewards in response to controllable or uncontrollable, long or short life primes and the control condition of experiment 2.

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

455 we use experiment 2 to rule out the possibility of a normative effect. In experiment 2, in the
456 controllable mortality condition, the norm was that people were dying younger because of
457 poor health habits. The selection of fruit still increased in this condition, relative to the
458 uncontrollable and control conditions, suggesting that the result of experiment 1 was not due
459 to a normative effect.

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

464 **Experiment 3: Replication of the controllability priming effect in a surreptitious field** 465 **experiment**

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

478 **Methods**

479 *Recruitment*

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

495 *Covariates*

496 Age was calculated from the date of birth entered on the polling cards. As in the two online
497 experiments, postcode IMD score was also used.

498 *Primes*

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

513 *Outcome variable*

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

516 *Analysis*

517 As in experiments 1 and 2, the effects of treatment on reward choice were evaluated using
518 binary logistic regression. In model 1 we assessed the effects of the covariates, so that any
519 that had a significant effect could be included in the model for treatment effect (model 2).

520 **Results**

521 *Descriptive statistics*

522 There were 121 participants in the uncontrollable treatment, and 116 in the controllable
523 treatment. Ages ranged from 15 to 87 years. IMD scores ranged from 3.75 to 74.48 (of a
524 possible 0.53-87.80) with a mean of 27.91.

525 There was no significant difference in the ages of the participants across treatments ($t_{229}=-$
526 0.78 , $p=0.43$). There was also no significant difference in the IMD score of participants’
527 postcodes across the treatments ($t_{227}=-0.16$, $p=0.875$).

528 *Main results*

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

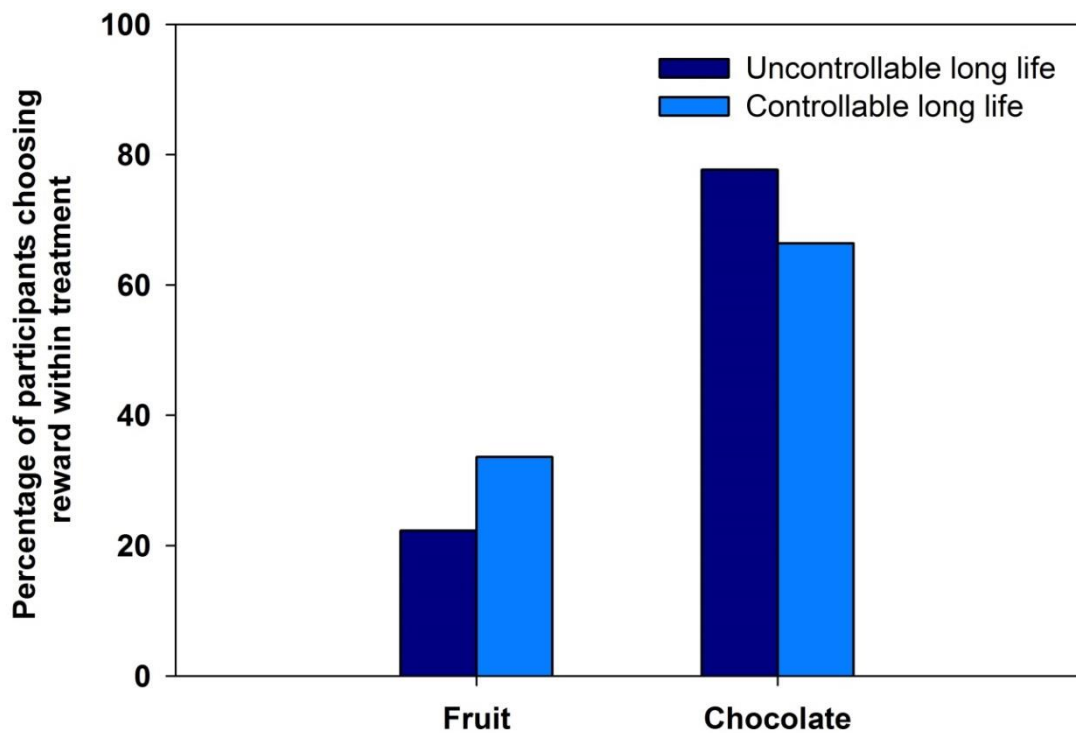


Figure 3. Experiment 3 results. The percentage of participants who chose fruit or chocolate rewards in response to controllable or uncontrollable long life primes.

Table 2. 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)	0.177
Neighbourhood deprivation score	1.00 (0.98-1.02)	0.825

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)

544 **Experiment 3 discussion**

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

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

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

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

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

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

577 **Overall discussion**

578 The results of our online and field experiments lend support to the Uncontrollable Mortality
579 Risk Hypothesis. They suggest that perceptions about the controllability of mortality risk may
580 have an important influence on health behaviours. Experiment 1 was the first, to our
581 knowledge, to demonstrate an effect of uncontrollable mortality priming on health-related
582 decision. Experiment 2 was the first to separate out the effects of uncontrollable and
583 controllable mortality primes on a health-related decision. Experiment 3 replicated the main

584 effect of the first two experiments in a surreptitious experiment, suggesting that the effect
585 seen in the first two experiments was not due to any demand characteristic.

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

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

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

605 The Extended Parallel Process Model states that messages depicting threats will be acted
606 upon to the extent that the available solutions are seen to be effective (Witte & Allen, 2000).
607 It proposes that a threat must have severe consequences in order to gain people's attention and
608 motivate them to act. In addition to this, the recommended action must be perceived to be
609 highly effective for this motivation to be translated into behavioural change. However, our
610 result suggests that a threat does not need to be overt for an effect to be seen. In our
611 experiments, there were no dramatic fear appeals. We simply mentioned that people of the
612 participant's demographic were either living longer (or not) than average and manipulated the
613 causes to be more or less controllable. In experiment 3, health was barely mentioned and no
614 health advice was given. Nonetheless, we saw a switch to a healthier reward choice. This is
615 likely to be because the choice was between two foods which are widely known to be healthy
616 (fruit) and unhealthy (chocolate). No further health information was needed. This
617 demonstrates that fear appeals may not be necessary to motivate behaviour change. In some
618 cases, where the healthy choice is widely known to be so (e.g. to not smoke), recommended
619 health actions may not be needed. It may be enough simply to reduce perceived (or better still,
620 actual) uncontrollable mortality risks. Indeed, the fact that uncontrollable mortality risk alters
621 the likely payoff of investing in health, could help to explain why interventions intended to
622 improve health behaviours simply by giving information have been ineffective (e.g. Buck &
623 Frosini 2012; Downs et al. 2013). Merely giving information could be insufficient to change
624 motivation (Pepper & Nettle, 2014b; White, Adams, & Heywood, 2009), especially when the

625 information given only pertains to risks already perceived as controllable and does nothing to
626 reduce the severity of any uncontrollable risks perceived.

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

635 More research on the effects of uncontrollable mortality risk is needed. If mortality
636 controllability priming could be used to increase motivation towards healthy behaviours, then
637 it is important to test it in new populations and situations and to learn more about when it
638 works. For example, our primes were effective in a situation where people were being offered
639 a food reward free-of-charge. However, the situation may be different when people are paying
640 for the food themselves. Our reward options were binary (fruit versus chocolate). Results may
641 be different if there is a range of options to choose from – especially if the options are less
642 obviously healthy and unhealthy ones. Furthermore, the experiments we have run so far have
643 only examined food choice. We do not currently know whether such primes can be used to
644 influence other health-related decisions. Finally, although this is beyond the scope of the
645 hypothesis, it is possible that control over factors other than mortality risk may influence
646 health behaviour. Future experiments could include additional treatments, which prime the
647 controllability of risks unrelated to mortality, such as the risks of becoming unemployed or
648 becoming a victim of theft.

649 It is also important to learn more about perceptions of the controllability of common mortality
650 risks. Understanding where perceptions come from could help policy makers to influence any
651 sources of information which lead to misconceptions. For example, if media scare stories bias
652 perceptions of uncontrollable mortality risk, then increasing awareness of this issue among
653 journalists and calling for increased journalistic responsibility would be important.

654 The effect of controllability may go beyond health behaviour. It is possible that the
655 controllability of mortality risk influences a range of behaviours involving trade-offs between
656 costs and rewards in the present and those in the future. When the risk of death is high (and
657 cannot be mitigated), the odds of being alive to receive future rewards are reduced. Thus,
658 people who believe they have a high and uncontrollable risk of mortality should be less
659 future-oriented than those who believe that they can control their mortality risk. There is some
660 support for this idea in the existing literature. Differences in time perspective have been
661 shown to be associated with a variety of health behaviours (Adams & Nettle, 2009; Adams &
662 White, 2009; Adams, 2009), and with differences in reproductive scheduling (Daly & Wilson,
663 2005; Kruger, Reischl, & Zimmerman, 2008; Pepper & Nettle, 2013). There is also evidence
664 to suggest that differences in time perspective could be caused by exposure to signals of
665 mortality risk. For example, future discounting has been found to be steeper in people who

666 had experienced a larger number of recent bereavements (Pepper & Nettle, 2013) and in
667 recent earthquake survivors, compared to controls (Li et al., 2012).

668 The results of our experiments support the idea that perceptions about the controllability of
669 mortality risk may be an important factor influencing people's health-related decisions. This
670 finding is congruent with other evidence about the importance of Health Locus of Control for
671 health (Burker et al., 2005; Holt et al., 2000; Poortinga et al., 2008; Wardle & Steptoe, 2003;
672 Williams-Piehota et al., 2004) and the influence of mortality priming on behaviour
673 (Griskevicius, Delton, Robertson, & Tybur, 2011; Griskevicius, Tybur, Delton, & Robertson,
674 2011; Mathews & Sear, 2008). However, our Uncontrollable Mortality Risk Hypothesis is
675 subtly different to other perspectives in the health literature and the results of our experiments
676 suggest that the difference may be a crucial one.

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

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