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Original Article

Death and the time of your life: experiences of close bereavement are associated with steeper financial future discounting and earlier reproduction

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ABSTRACT

Evolutionarily-based theories predict that people should adopt a faster life history strategy when their mortality risk is high. However, this raises the question of what cues evolved psychological mechanisms rely on when forming their estimates of personal mortality risk. In a sample of 600 North Americans, we examined associations between ideal or actual reproductive timing and two possible cues to mortality risk: 1) the total number of people a person knew who had died (death exposure); and 2) the number of those people to whom they felt close (bereavement). We also took a measure of financial future discounting, in order to establish whether experiences of death or bereavement are associated with a more general shortening of time horizons. We found that a greater number of bereavements were robustly associated with a lower ideal age at first birth, or an increased hazard of an actual first birth at any given age and with steeper future discounting. We did not find significant associations between any of these outcomes and overall death exposure. This suggests that the deaths of people with whom one is close may be a more salient cue for the calibration of reproductive and financial time horizons than the deaths of more distant acquaintances.

1. Introduction

A prediction commonly made in human behavioural ecology is that when the risk of mortality is high, people should start to reproduce earlier in their lives, at the expense of other investments (Chisholm et al., 1993; Nettle, 2011; Wilson & Daly, 1997). Evidence suggests that ages at first birth are indeed lower in human populations where mortality rates are high (Bulled & Sosis, 2010; Low, Hazel, Parker, & Welch, 2008; Nettle, Coall, & Dickins, 2011; Nettle, 2010a; Quinlan, 2010), and that birth rates can increase following a sudden and salient increase in local mortality (Rodgers, St John, & Coleman, 2005). However, relatively little is known about exactly which cues to mortality are important in shaping people's reproductive decisions in real-world settings. Moreover, it is not currently clear whether cues to mortality influence reproductive decision-making in a domain-specific way, or cause a shortening of psychological time horizons more generally. Several authors have predicted a general shortening of time horizons in response to mortality risk (Hill, Jenkins, & Farmer, 2008; Kruger, Reischl, & Zimmerman, 2008; Wilson & Daly, 1997). This would include a preference for smaller rewards that will be received sooner rather than larger ones to be received later (future discounting). Thus, we might expect both earlier reproduction and steeper future discounting to occur in response to cues indicative of local mortality rates (Griskevicius, Delton, Robertson, & Tybur, 2011; Griskevicius, Tybur, Delton, & Robertson, 2011; Wilson & Daly, 1997). Here, after reviewing some of the relevant literatures, we examine the associations between ideal and actual ages at first birth, future discounting and two potential environmental cues to mortality risk: 1) overall exposure to death and 2) close bereavements, in a survey of 600 North Americans.

1.1. Mortality risk and initiation of reproduction

Models of the evolution of life histories predict that species facing high mortality rates should start to reproduce at a younger age (Stearns, 1992), and this prediction is borne out by comparative evidence (see Harvey & Zammuto, 1985). An extension of this concept within human behavioural ecology is the idea that humans have evolved the capacity to ontogenetically calibrate their reproductive strategies in response to local mortality risk (e.g. Chisholm et al., 1993; Lawson & Mace, 2011; Nettle, 2011). As mortality risk increases, the benefits of earlier reproduction become greater. Earlier reproduction both increases the likelihood of reproducing (before death), and maximises the length of time for which the parent will be available to provide care for the child. Conversely, where mortality risk is lower, the benefits of delaying reproduction become greater. Delay allows for greater somatic development or the accrual of resources that could subsequently be invested in children. Thus, people who have a lower mortality risk and the ability to accrue resources or improve their condition should delay the initiation of reproduction. Meanwhile, those faced with high mortality risks and low resource gathering potential should reproduce as sooner. The

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evidence suggests that this is what people do. Across countries, there is a strong association between mortality rates and age at first birth (Bulled & Sosis, 2010; Low, Parker, Hazel, & Welch, 2013; Low et al., 2008). The same patterns can be seen among individuals within countries (Nettle, 2010a; Quinlan, 2010; Wilson & Daly, 1997). However, we know little about the environmental cues that trigger these changes in reproductive strategy in humans. A handful of studies have begun to investigate such cues. For example, one study found that girls who perceive that they live in an unsafe environment have higher odds of becoming teen mothers than girls who believe that their environment is safe (Johns, 2010). Some psychological experiments have also demonstrated that mortality primes influence participants' attitudes to reproduction, including their ideal ages at first birth (Griskevicius, Delton, et al., 2011; Mathews & Sear, 2008). However, the artificial cues used in such experiments may not be those that are of importance to real world behaviour. Thus, we used observational data to explore which experiences were most strongly associated with reproductive schedules. We predicted that greater exposure to death and bereavement would be associated with earlier ideal or actual ages at first birth.

1.2. Mortality risk and future discounting

Altering reproductive strategy in line with cues to mortality risk may be a domain-specific response restricted to reproductive motivations, or it may be part of a more general shift in time horizons. In the same way that it makes adaptive sense to have children at an earlier age if mortality risk is high, it may make sense to prioritise immediate rewards and costs over delayed ones (Wilson & Daly, 1997). If the risk of death is high, the odds of being alive to receive future rewards are reduced. Future discounting is the tendency to choose smaller–sooner rewards over later–larger ones. It is conceptually aligned with time horizons and is often used as a measure of them (Adams, 2009; Daugherty & Brase, 2010; Teuscher & Mitchell, 2011). Some authors have proposed that changes in time horizon are a mechanism for functional developmental adaptation to uncertain environments (Hill et al., 2008; Kruger et al., 2008). One feature of such uncertain environments could be high mortality risk. However, there is still much to be learned about how cues to mortality are related to future discounting. One laboratory experiment demonstrated that people who reported low childhood socioeconomic status (SES) and were exposed to mortality primes discounted the future more steeply than those who were not exposed to mortality primes (Griskevicius, Tybur, et al., 2011). Exposure to violence has been found to be associated with future discounting (Ramos, Victor, Seidl-de-Moura, & Daly, 2013) and earthquake survivors discount future rewards more steeply than controls (Li et al., 2012). Evidence from health psychology suggests that bereavement may be a trigger for impulsive behaviours (e.g. Stroebe, Schut, & Stroebe, 2007). For example, young people who lose their parents suddenly and unexpectedly perform more health risk behaviours than controls (Hamdan et al., 2012). If exposure to death or bereavement triggers a shortening of time horizons, then this could help to explain the association between bereavement and impulsive behaviours. However, to our knowledge associations between general exposure to death, bereavement and future discounting have not yet been examined. We examined them and predicted that greater exposure to death and bereavement would be associated with steeper future discounting.

1.3. Exposure to death and close bereavements as cues to mortality risk

There has been limited research into the relative importance of environmental cues to personal mortality risk. However, there is some evidence regarding the types of cue that might be important. Exposure to violence is known to be associated with future discounting (Ramos et al., 2013) and with health-risk behaviours among adolescents - including early initiation of sexual intercourse (Berenson, Wiemann, & McCombs, 2001). Perceived environmental risk is a predictor of teen motherhood (Johns, 2010). Experimental mortality risk priming both increases future discounting (Callan, Willshead, & Olson, 2009; Griskevicius, Tybur, et al., 2011) and alters attitudes about having children (Griskevicius, Delton, et al., 2011; Mathews & Sear, 2008). One very simple possible cue to mortality risk may be the number of deaths to which one is exposed. If these are a reflection of rates of mortality in one's environment, they may be a good indicator of one's own mortality risk. People may behave according to a simple rule of thumb such as, "each time someone you know dies, shorten your time horizons a bit". However, deaths of close friends or relatives may be more important still. Relatives will share one's genes and therefore are likely to have similar vulnerabilities to disease (Manolio et al., 2009). They are also likely to share one's environment, which may be the source of the mortality risk. Similarly, close friends are likely to share one's environment. They are also more likely to share other characteristics, such as age, gender or personal habits, than mere acquaintances. Such shared characteristics may make their vulnerability to mortality risks a good reflection of one's own. Therefore, overall exposure to death may act as a mortality cue, but the deaths of people with whom one identifies closely may be given a greater weight than the deaths of others.

1.4. Predictions

In the current study, we tested associations between exposure to death (number of a person's acquaintances who died), close bereavements (number of people a person felt close to who died) and ideal and actual ages at first birth, as well as future discounting. We predicted: 1) that both exposure to death and close bereavement would be associated with lower ideal and actual ages at first birth and steeper future discounting, and; 2) that the effect of close bereavements would be greater than the effect of overall exposure to death.

2. Methods

The Newcastle University Faculty of Medical Sciences Ethics Committee approved our study. Six hundred North American volunteers were surveyed anonymously online using the SocialSci survey platform [www.socialsci.com]. Our sample had previously been recruited by SocialSci to take part in surveys via this platform. SocialSci recruit using a distributed online advertising network, print media and live recruitment. They award Amazon credit to respondents for taking part in their surveys. Our respondents completed an electronic consent form before proceeding. They were asked for their age, gender and gross annual income ($USD). We asked if they had children and asked them for their ideal or actual ages at first birth (as appropriate - see below). We measured future discounting using a series of monetary choice tasks (below). After collecting these outcome measures, we asked about recent exposure to deaths and close bereavements and took a subjective measure of SES (below). The questionnaire is available as a supporting document (available on journal's website at www.ehbonline.org).

2.1. Ideal and actual ages at first birth

Respondents were asked whether they had children. If they had children, we asked, "How old were you when your first child was born?" If they did not have children, we asked, "What would be your ideal age to start having children?" Respondents selected their ideal and actual ages at first birth from a drop-down menu with choices ranging from 16 to 45 years of age. Prior studies have shown that reported ideal age at first birth is a strong predictor of subsequent actual age at first birth (Nettle, Coall, & Dickins, 2009). Therefore, we were confident that ideal age at parenthood would be a good indicator of reproductive strategy for the currently childless participants.

2.2. Future discounting

Respondents were offered a series of 20 hypothetical choices between a larger monetary reward "in a year's time" (the delayed reward) and a smaller monetary reward "today" (the immediate reward). The delayed rewards were held constant at \$100, while the immediate rewards ranged from \$1 to \$99. The range of k parameters (k expresses the point of indifference between immediate and delayed rewards) represented by these choices were between 0.271232 and 0.000027 (where $k = (A\text{-}V)/(VD)$, A is the amount of the delayed reward, V is the present subjective value of the delayed reward and D is the delay). This covers a slightly larger range of k than can normally be expected in similar populations (Kirby & Maraković, 1995; Kirby, Petry, & Bickel, 1999). To encourage consistent answers, the immediate reward choices were arranged in ascending order from \$1 to \$99 with both the delayed reward choices and the delay period held constant.

2.3. Exposure to death and close bereavements

To avoid any priming effects (Mathews & Sear, 2008), we asked questions about deaths at the end of the survey. We asked participants whether anyone they knew had died in the past 5 years. Those who said yes were then asked, "How many people that you know have died in the past five years?" This was our measure of exposure to death. We then asked, "How many of those people did you feel you were very close to?" We will refer to this measure as the number of close bereavements. We asked about deaths in the past 5 years rather than deaths over a longer period because we felt that our participants were more likely to remember recent deaths accurately. In addition, deaths that are more recent should be a better assay of current mortality risk than deaths in the more distant past.

2.4. Subjective SES measure

Respondents were asked to complete a subjective measure of SES taken from prior studies by Griskevicius et al. (Griskevicius, Delton, et al., 2011; Griskevicius, Tybur, et al., 2011). Respondents were asked to rate their agreement on a scale from one (strongly disagree) to seven (strongly agree) with the statements: a) "I don't worry too much about paying my bills"; b) "I have enough money to buy things I want", and; c) "I don't think I'll have to worry about money too much in the future." The three responses correlated well with one another ($r = 0.53$–0.63, $p < 0.001$) and were therefore summed to give an overall subjective SES score. It was important to control for SES because, as explained above, resource availability should influence reproductive scheduling in tandem with mortality risk (Nettle, 2010a). In addition, lower SES individuals are known to discount future rewards more steeply than higher SES individuals (Adams, 2009; Adams & Nettle, 2009). We used this subjective SES measure alongside the more objective measure of income, because we wanted to be able to include younger respondents (who could be, or could become, teen parents) in the analysis. For younger respondents, measures such as income or education are not a good reflection of SES, because younger people are often still financially dependent upon parents and have not yet completed their education. Meanwhile, measures such as parental income are often inaccurately reported (Boyce, Torsheim, Currie, & Zambon, 2006) and cannot be easily compared with the incomes of the older respondents in the sample.

2.5. Analysis

Statistical tests were run in SPSS version 19.0. Age, sex, income (square root transformed) and subjective SES score were controlled in all models. We used a general linear model (GLM) to test associations between exposure to death and bereavement and ideal age at first birth for those participants who had not yet had children. We then tested the associations between exposure to death and close bereavements and actual age at first birth separately: We used Cox regression to assess the proportional hazard of a first birth at any given age, based on exposure to death and close bereavements, with sex, income and SES controlled in the model. We used a GLM to test associations between exposure to death and bereavement and future discounting for all participants, again with age, sex, income and SES controlled. We used Pearson correlations to assess the relationship between future discounting and ideal and actual ages at first birth.

3. Results

3.1. Descriptive statistics

The raw data are available as supporting online material. Of the 600 respondents, 262 (44%) were male, 336 (56%) were female and two did not report their sex. Respondent ages ranged from 13 to 72 years (see Table 1 for descriptive statistics). Four hundred eighty-one (80%) of our respondents had been exposed to one or more deaths in the prior 5 years. One hundred twenty-three (21%) of the sample had children. Subjective SES scores ranged from the minimum possible score of 3 to the maximum possible score of 21. The highest number of deaths reported was 30, with the mean being close to two. The highest number of close bereavements reported was 28, with a mean close to one. Ideal ages (non-parents) and actual ages (parents) at first birth had similar ranges (Table 1).

3.2. Exposure to death and bereavement and ideal ages at first birth

There was no association between death exposure and ideal age at first birth (Table 2). However, the number of close bereavements was significantly associated with ideal age at first birth, even with age, sex, income and SES controlled. The negative parameter value ($B = -0.46$) indicates that a larger number of close bereavements was associated with an earlier ideal age at first birth. In addition to the effect of close bereavements, there were sex differences in ideal age at

Table 1
Descriptive statistics for age, income, SES, death exposure, close bereavements, age at first birth, ideal age at first birth and future discounting.

	Range	Minimum	Maximum	Mean	Standard deviation
Age	59.00	13.00	72.00	27.16	9.86
Income (\$USD)	1500000.00	0.00	1500000.00	40035.53	87842.72
SES	18.00	3.00	21.00	11.30	4.84
Death exposure	30.00	0.00	30.00	2.41	2.80
Close bereavements	28.00	0.00	28.00	0.95	1.63
Age at first birth	27.00	16.00	43.00	25.49	5.36
Ideal age at first birth	29.00	16.00	45.00	29.37	4.39
Future discounting	20.00	0.00 ($k < 0.27123$)	20.00 ($k \geq 0.00003$)	8.74	5.38

Discount parameter, $k = (A\text{-}V)/(VD)$, where A = delayed reward, V = immediate reward and D = delay.

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Table 2
GLM results for ideal age at first birth with age, sex, income, SES, death exposure and bereavements in the model.

	F ratio	p	B	Standard error [B]	Lower bound (95% CI)	Upper BOUND (95% CI)
Age	15.35	0.00*	0.12	0.03	0.06	0.17
Sex†	4.48	0.03*	0.82	0.39	0.06	1.58
Income	0.22	0.64	0.00	0.00	−0.01	0.00
SES	1.40	0.24	−0.05	0.04	−0.13	0.03
Death exposure	0.05	0.82	−0.02	0.10	−0.21	0.17
Bereavement	4.28	0.04*	−0.46	0.22	−0.89	−0.02

Being female and having reported a greater number of bereavements were associated with earlier ideal ages at first birth.
df = 1, error = 452, p = significance.
* $p \leq 0.05$.
† The reference category is female, so the ideal age at first birth is higher for males.

first birth, with males reporting a slightly higher mean ideal age than females. Ideal ages at first birth were also slightly higher in older respondents.

3.3. Exposure to death and bereavement and actual ages at first birth

Of the 600 respondents, 123 (20%) of the respondents had children and 477 (79%) did not (censored cases in the Cox regression). Thirteen cases had missing values for deaths or bereavement. As predicted, experiences of close bereavement were associated with an increased hazard of having a first child at any given age (Table 3, Fig. 1). One or two bereavements did not significantly increase the hazard of having had a child at a given age relative to those who reported no bereavements. However, there was a significantly greater hazard of a first birth at a given age for those reporting 3–4 or 5+ bereavements relative to those reporting no bereavements. Indeed, the hazard of a first birth at each age roughly doubled with each level of bereavement (Fig. 1). Being male was associated with a decreased hazard of having a first child at a given age. Total death exposure did not affect the hazard of a first birth (Table 3). This result mirrors our finding for ideal ages at first birth in the childless participants.

3.4. Exposure to death and bereavement and financial future discounting

Even with age, sex, income, SES and more general death exposure controlled, the number of close bereavements was associated with financial future discounting (Table 4). The effect of bereavements was in the predicted direction, with a higher number of bereavements being associated with a higher future discounting score. That is, respondents who reported a larger number of close bereavements tended to select smaller sooner rewards rather than later larger ones. Subjective SES was also a predictor of future discounting, with higher SES being associated with a lower future discounting score. That is, people of higher SES tended to prefer to wait for later larger rewards.

3.5. Future discounting and ideal and actual ages at first birth

Pearson correlations revealed an association between future discounting and both ideal and actual ages at first birth (Table 5). Respondents who discounted the future more steeply had lower ideal and actual ages at first birth. The association between future discounting and actual age at first birth was stronger than the association between discounting and ideal age at first birth.

4. Discussion

We predicted: 1) that both exposure to death and close bereavement would be associated with lower ideal and actual ages at first birth and steeper financial future discounting, and; 2) that the effect of close bereavements would be greater than the effect of overall exposure to death. Part of prediction 1) was supported by the data. We found that a greater number of reported bereavements were associated with a lower ideal age at first birth, an increased hazard of a

Table 3
Cox regression results: hazards of having a first child at each age, given sex, income, SES, death exposure and level of close bereavement experienced.

	Hazard	Lower CI	Upper CI	p
Sex†	0.586	0.394	0.873	0.009*
Income	1.003	1.001	1.004	0.000*
SES	0.963	0.927	1.000	0.050*
Death exposure	1.006	0.948	1.067	0.848
Bereavements††				0.002*
1–2 bereavements††	1.351	0.880	2.073	0.169
3–4 bereavements††	2.546	1.164	5.568	0.019*
5+ bereavements††	5.442	2.228	13.292	0.000*

CI = 95% confidence interval, p = significance.
Level of reported bereavement was associated with age at first birth, even with sex, income, SES and more general death exposure controlled (see also Fig. 1.).
* $p \leq 0.05$.
† The reference category is female, so the hazard of having a first child at each time point is lower for males.
†† The reference category is no bereavement, so the hazard of having a first child at each time point was greater for respondents who reported 3–4 or 5+ bereavements, than for those who reported no bereavements. However, the hazard for respondents who reported 1–2 bereavements was not significantly greater than those who reported none.

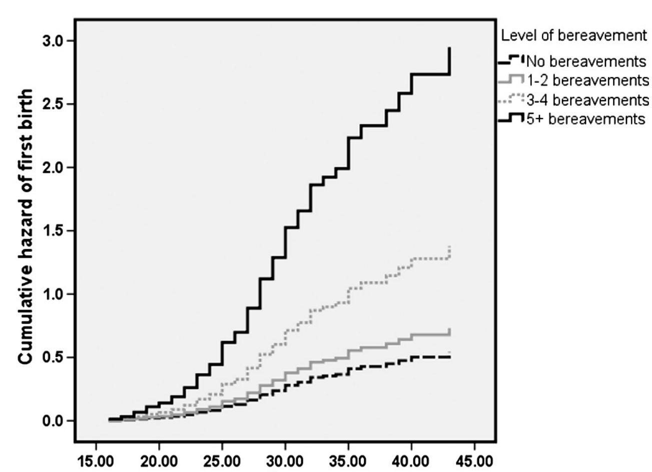

Fig. 1. Cumulative hazards of having a first child at a given age for four levels of close bereavement: no bereavement; 1–2 bereavements; 3–4 bereavements; and 5+ bereavements. Sex, income, SES and more general death exposure are controlled (see Table 3).

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Table 4
GLM results for future discounting with age, sex, income, SES, death exposure and bereavements in the model.

	F ratio	p	B	Standard error [B]	Lower bound (95% CI)	Upper bound (95% CI)
Age	0.17	0.68	0.01	0.03	−0.04	0.06
Sex	0.02	0.90	0.06	0.45	−0.83	0.94
Income	0.04	0.83	0.00	0.00	−0.01	0.00
SES	10.16	0.00*	−0.15	0.05	−0.24	−0.06
Death exposure	3.02	0.08	−0.18	0.10	−0.38	0.02
Bereavement	6.63	0.01*	0.45	0.18	0.11	0.79

SES and reported number of bereavements were significant predictors of future discounting score. A higher future discounting score indicates a greater tendency to choose a smaller sooner reward over a later larger one. A greater number of reported bereavements were associated with a greater tendency to choose a smaller sooner reward over a later larger one. A lower SES score was associated with a greater tendency to choose a smaller sooner reward over a later larger one.
df = 1, error = 571, p = significance.
* $p \leq 0.05$.

first birth at any given age, and steeper future discounting. This finding held true, even after controlling for age, sex, income and SES. However, we did not find significant associations between general exposure to deaths and ideal or actual ages at first birth. In support of prediction 2, our findings suggest that experiences of close bereavement, more so than exposure to deaths in general, act as a cue to mortality risk. This could be because the deaths of people with whom one is close are a better indicator of one's own mortality risk than the deaths of more distant acquaintances. To our knowledge, there has been no prior research examining bereavement as a cue that might affect reproductive timing. Prior studies have examined the association between mortality rates and ages at first birth within and between countries (Bulled & Sosis, 2010; Low et al., 2008; Nettle, 2010a, 2011; Wilson & Daly, 1997). Others have demonstrated that early life stress and other cues to a harsh environment are associated with faster life history strategies (e.g. Chisholm, Quinlivan, Petersen, & Coall, 2005; Chisholm et al., 1993). However, this is the first study we know of that has investigated how personal experiences may act as environmental cues to mortality risk and trigger differences in life history strategy. This study bridges a gap between the demographic findings that show associations between mortality and ages at first birth (e.g. Low et al., 2008) and the experimental studies that find priming effects of mortality (e.g. Griskevicius, Delton, et al., 2011). It gives us additional information about what sort of cues ought to be most important for life history strategies in real populations. Furthermore, our results tell us that laboratory studies using mortality priming might only be expected to produce small effects. The nature of cues – for example the person whose death the participant is primed with – will be important.

As well as suggesting that bereavement may exert an influence on reproductive decision-making, our results suggest that it affects future discounting, and thus time horizons, in a more general way. This finding converges with those from the public health literature, which show associations between bereavement and impulsive health risk behaviours (Hamdan et al., 2012). It also confirms the predictions of Wilson and Daly (1997), Kruger et al. (2008) and Hill et al. (2008), that steeper future discounting across a range of domains may be part of a suite of psychological adjustments that produce a faster life-history strategy.

Although our income and subjective SES measures were not associated with ideal age at first birth, they did predict actual age at first birth and the subjective SES measure predicted financial future discounting. Prior research has documented associations between income and future discounting (e.g. DeWit, Flory, Acheson, Mccloskey, & Manuck, 2007). However, in our sample, close bereavements and subjective SES, but not incomes, were associated with future discounting score. The lack of an association between income and future discounting may have been due – as previously discussed – to the fact that income is not a good measure of SES for younger participants. In addition, the subjective SES score captured more fine grained aspects of resource availability, such as disposable income (2.4,b) and financial stability (2.4,c).

It should be noted that we did not find an association between age and future discounting. Prior studies have found that younger individuals discount the future more steeply than older ones (e.g. Green, Fry, & Myerson, 1994), while others have not supported such findings (e.g. Green, Myerson, Lichtman, Rosen, & Fry, 1996). This may have been because income is a confounding factor in some studies. For example, the former study (Green et al., 1994) compared discount rates in children, young adults and older adults, but did not control for income or other SES measures. The latter study (Green et al., 1996), which found no association between age and future discounting, compared 30-year-olds with income-matched 70-year-olds. We also found no sex differences in future discounting in our sample. Perhaps this is not surprising, as support for gender differences in prior studies has been mixed. Studies have found that: women discount the future more steeply than men (Reynolds, Ortengren, Richards, & Dewit, 2006); that men discount future rewards more steeply than women (Kirby & Marakovic, 1996), and that there is no significant sex difference (Harrison, Lau, & Williams, 2002; Wilson & Daly, 2004).

There are some limitations to our data set. It was an opportunity sample and so was not population representative. In addition, respondents who already had children when surveyed may have had them before the deaths that we recorded with our 5-year death exposure measure. Therefore, we cannot conclude that the bereavements captured by our questions resulted in the lower ages at first birth. However, our data is cross sectional and it is not generally possible to infer causality in such data anyway. Furthermore, it is possible that, even after controlling for age, those respondents who reported greater exposure to death and bereavement in the 5 years prior to questioning had experienced similar levels of bereavement in their earlier years. In general, it is difficult to draw conclusions about causality on the basis of correlational data. However, the relationships we report here are robust to control for age, sex, income and subjective SES measures. Furthermore, the results are consistent with

Table 5
Correlations between future discounting scores and ideal or actual ages at first birth.

	Age at first birth	Ideal age at first birth	Age at first birth and ideal age at first birth (combined)
n	123	477	600
Future discounting	−.310*	−.158*	−.227*

A higher future discounting score indicates a greater tendency to choose a smaller sooner reward over a later larger one. Thus, a greater tendency to choose smaller sooner rewards over later larger ones is associated with earlier ideal and actual ages at first birth.
n = sample size.
* $p \leq 0.05$.

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findings from laboratory mortality priming experiments and may reflect the way in which such mortality cues produce effects in the real world (Callan et al., 2009; Griskevicius, Delton, et al., 2011; Griskevicius, Tybur, et al., 2011). Nevertheless, further investigations using longitudinal data and experimental work are warranted in order to address the causality issue. Finally, the structure of our survey only permitted respondents to select an ideal age at first birth. It did not allow them to state that they did not desire children at all. This is a limitation because we will be unaware of respondents who do not wish to have children and perhaps should have been treated differently in our analyses.

The fact that we found an effect of bereavement, but not of death exposure may tell us something about the psychological mechanisms involved in processing cues to personal mortality risk. Statistics about deaths have been found to have a lesser emotional impact when they cite large numbers (Slovic, 2007) and they appear to motivate different decisions about the value of lives (Fetherstonhaugh, Slovic, Johnson, & Friedrich, 1997). If people use some sort of availability heuristic (Tversky & Kahneman, 1973) to assess their own mortality risk, then detailed knowledge of individual deaths may distort responses to risk of mortality by the same cause. For example, Sunstein (2003) discusses how the use of availability heuristics could lead to probability neglect. He explains that in the aftermath of a terrorist attack, repeat attacks can be more readily imagined (availability heuristic), and so people tend to over-estimate the likelihood that they will happen. This leads people to react with a fear which is out of proportion to the risk of such an event occurring. If close bereavements lead to a particular cause of death being more readily imagined, then they may skew perceptions of the risk of death due to that cause. However, it is possible that a mechanism more complex than an availability heuristic is at work. For example, people may calculate fatality proportions rather than fatality frequencies. That is, for a person with a smaller social network, each death may have a greater weight than for a person with a larger social network. Future studies might address this by collecting measures of social network size alongside measures of exposure to death and bereavement.

The nature of the causes of death will also be important. There is evidence to suggest that extrinsic mortality risk (risk of death to circumstances beyond the individual's control) is important in determining behaviour (Nettle, 2010b; Pepper & Nettle, 2013). We therefore suggest that individuals who experience close bereavements due to extrinsic causes will have shorter time horizons than those whose bereavements are due to intrinsic causes. Future studies should investigate this possibility in more detail.

In conclusion, our results suggest that close bereavements act as a cue to mortality risk, triggering an accelerated life history strategy. The sheer number of deaths a person reported did not show significant effects. This may be because the deaths of a person with whom one is close are a better reflection of one's own mortality risk due to shared genes and or environment. Furthermore, we found that the number of close bereavements reported was associated with financial future discounting. This indicates that cues to personal mortality risk may provoke a more general shortening of time horizons. Thus, the response may not be unique to the reproductive domain.

Supplementary Material

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.evolhumbehav.2013.08.004.

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