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The behavioural constellation of deprivation: Causes and consequences

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Abstract: Socioeconomic differences in behaviour are pervasive and well documented, but their causes are not yet well understood. Here, we make the case that a cluster of behaviours is associated with lower socioeconomic status (SES), which we call "the behavioural constellation of deprivation." We propose that the relatively limited control associated with lower SES curtails the extent to which people can expect to realise deferred rewards, leading to more present-oriented behaviour in a range of domains. We illustrate this idea using the specific factor of extrinsic mortality risk, an important factor in evolutionary theoretical models. We emphasise the idea that the present-oriented behaviours of the constellation are a contextually appropriate response to structural and ecological factors rather than a pathology or a failure of willpower. We highlight some principles from evolutionary theoretical models that can deepen our understanding of how socioeconomic inequalities can become amplified and embedded. These principles are that (1) small initial disparities can lead to larger eventual inequalities, (2) feedback loops can embed early-life circumstances, (3) constraints can breed further constraints, and (4) feedback loops can operate over generations. We discuss some of the mechanisms by which SES may influence behaviour. We then review how the contextually appropriate response perspective that we have outlined fits with other findings about control and temporal discounting. Finally, we discuss the implications of this interpretation for research and policy.

Keywords: behaviour; delay discounting; evolution; extrinsic mortality; health; inequalities; personal control; socioeconomic status; temporal discounting; time perspective

1. Introduction

Socioeconomic inequalities in life outcomes, such as health and life expectancy, are an issue of concern to policy makers and to society as a whole. The public health literature is replete with efforts to understand the forces that generate and perpetuate health inequalities. This literature shows that differences in behaviour contribute substantially to socioeconomic disparities in health and mortality (Pampel, Krueger, & Denney 2010). Yet why the people in society who face the most challenging life circumstances should respond to them with behaviours that exacerbate their problems is deemed an unresolved paradox. Furthermore, evidence suggests that this paradox is not restricted to health behaviour. In their high-profile review of economic behaviour, Haushofer and Fehr (2014, p. 862) argued that "poverty may have particular psychological consequences that can lead to economic behaviours that make it difficult to escape poverty."

There have been thorough reviews of socioeconomic gradients in individual types of behaviour. For example, financial, health, and even environmental behaviours have been examined (Gifford & Nilsson 2014; Haushofer & Fehr 2014; Pampel et al. 2010). However, these articles address the literature in behavioural silos. They do not ask questions as to why *all* of these behaviours should be simultaneously socioeconomically patterned. The present article aims to address that gap in the literature. We first make the case that a cluster of behaviours is associated with socioeconomic status (SES; see Glossary – sect. 10). We call this cluster the behavioural constellation of deprivation (BCD; see sect. 2). We then present an explanatory approach to the BCD by establishing it as a contextually appropriate response to having limited control over the future outcomes of investments made in the present – an interpretation we call "the contextually appropriate response perspective" (sects. 2.1 and 2.2). We go on to illustrate how one specific uncontrollable factor, extrinsic mortality risk, should lead people to devalue the future (sect. 2.3), and then we discuss examples of other uncontrollable factors that may similarly influence behaviour (sect. 2.4). In the next section, we examine the ways in

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which the BCD may cause deprivation to become embedded and amplified through additive routes and feedback loops (sect. 3.2). We then review the psychological and physiological mechanisms by which limited control over future outcomes may lead to the BCD (sect. 4), emphasising that none of these mechanisms is necessarily incompatible with the contextually appropriate response perspective.

Some of the ideas we have pulled together in this review are well accepted in the evolutionary behavioural sciences (e.g., Del Giudice et al. 2004; Dunkel & Kruger 2014; Frankenhuis et al. 2016; Kruger et al. 2008; Tybur et al. 2012). Yet they do not seem to be widely discussed, or applied, in related fields, such as public health or developmental psychology, where they could be most useful. Thus, this article outlines how the contextually appropriate response perspective, which draws on evolutionary thinking, converges with, and differs from, other attempts to understand socioeconomic differences in behaviour in terms of control and temporal discounting (sects. 5 and 6). This is important, because evolutionary explanations are frequently assumed to be mutually exclusive of other explanations, an assumption that changes once we make the distinction between proximate and ultimate explanations (sect. 4; see also Pepper & Nettle 2014c). Finally, we highlight some key implications of the contextually appropriate response perspective for policy and future research (sect. 7) and make some necessary clarifications and caveats (sect. 8). By drawing together, explaining, and extending the principles listed previously, and their relevance to key empirical findings, we hope to promote their application and stimulate interdisciplinary debate around them.

A great deal of work has been done that is relevant to the topics discussed in this article. However, this article integrates ideas across the broad traditions of psychology, social science, and evolutionary biology, and it is not possible to cite all of the relevant literature. Thus, in the conceptual sections of this article, we acknowledge the works that best illustrate the story we want to tell, often citing only a selection of relevant articles for brevity.

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Daniel Nettle is a Professor of Behavioural Science at Newcastle University. He describes himself as both a biologist and a social scientist and sees no contradiction between the two. He received his Ph.D. in Anthropology from University College London and has subsequently worked on a number of questions mainly related to variation in life history, health, and behaviour. He is particularly interested in the consequences of deprivation and disadvantage across the life course, a topic he studies both in humans and in the European starling.

2. The behavioural constellation of deprivation

In this section, we review a cluster of behaviours that have been consistently found to vary with SES, the cluster we are referring to as "the BCD." Before we review these behaviours, it is helpful to remember that SES is a complex construct that aims to define a person's ranking in a social and economic hierarchy. It is generally measured by such factors as education, occupation, income, or wealth. However, subjective measures are often used, and neighbourhood-level factors, such as average house price, crime rates, and disrepair, have become popular (Braveman et al. 2005; Krieger et al. 1997; Lakshman et al. 2011). Thus, when researchers examine associations between SES and other factors, such as behaviour or health outcomes, we are often using SES as a proxy measure to capture the experience of being generally less well off than others in society. Our use of the term "deprivation" rather than "SES" in the BCD therefore represents an acknowledgment that it is not necessarily income, education, or occupation per se that should lead to differences in behaviour but the experience of various hardships, or deprivations, that are often associated with being of lower SES.

At first glance, the behaviours of the BCD may seem varied and unrelated. However, we argue that they have a common theme – that of balancing costs and benefits in the present with those likely to be realised in the future.

People of lower SES tend to incur more debt, save less for the future, and invest less in education than those of higher SES (Blanden & Gregg 2004; Chowdry et al. 2011; Lea et al. 1993; Livingstone & Lunt 1992; Sirin 2005; White 1982). They have children sooner, an effect most visible at its extreme with the consistent socioeconomic patterning of teen pregnancies (e.g., Imamura et al. 2007; Johns 2010; Nettle 2010a; G. D. Smith 1993). They also tend to invest less in their children, not only financially but also through other efforts, such as breastfeeding, reading to them, and taking an interest in their education (Hango 2007; Kiernan & Huerta 2008; Kohlhuber et al. 2008; Nettle 2010a).

Research has consistently uncovered socioeconomic gradients in a range of health behaviours. People of lower SES have poorer diets and are less physically active than those of higher SES (Brennan et al. 2009; Droomers et al. 1998; Everson et al. 2002; McLaren 2007; Mobley et al. 2006; Wardle et al. 2002). They are more likely to use illicit drugs and to drink excessive amounts of alcohol (Boyle & Offord 1986; Daniel et al. 2009; Droomers et al. 1999; Legleye et al. 2011; Mäkelä 1999; Méjean et al. 2013). They also smoke more and have greater difficulty in quitting smoking (Harrell et al. 1998; Kotz & West 2009; Legleye et al. 2011; Melotti et al. 2011). Some argue that lower-SES individuals exhibit less healthy behaviours because they are unable to "purchase" health. This may be true for some health behaviours. For example, a high-quality diet may be much more expensive than a poor-quality one (Darmon & Drewnowski 2008). However, financial restraints cannot explain some of the most common health-damaging behaviours: For such behaviours

as smoking and alcohol consumption, the unhealthy option (consumption) is more financially costly than the healthy one (abstinence). Thus, this clustering of unhealthy behaviour not only contributes substantially to socioeconomic inequalities in health and mortality, but also is an enduring conundrum in public health (Pampel et al. 2010).

2.1. Present-future trade-offs

All of the BCD behaviours that we have outlined above entail trade-offs between the present and future. For example, the decision to save money rather than to spend it immediately prioritises future needs and wants over present ones. Putting time, effort, and money into getting an education may yield future rewards, such as a better-paying job. However, resources invested in getting an education cannot be spent on other endeavours that may be more immediately rewarding. To invest in a child's well-being or education is to invest in the future of that child. However, those resources cannot be invested in other things. Similarly, healthy behaviour in the present often (although not always) involves forgoing an activity that is pleasurable in the short term, such as smoking, drinking alcohol, or eating sugary foods, to prevent potentially detrimental health effects in the future. It might also involve investing time, money, or energy in doing exercise that can (for some) feel unpleasant in the present but should pay health dividends in the future. These present-future trade-offs are not the *only* factor involved in the BCD. However, we propose that they are a core element – a common thread linking all of the behaviours in the constellation.

Myriad concepts in the literature are related to the idea of trade-offs between costs and benefits in the present and in the future. We have defined these terms and their relationships to one another in the Glossary (sect. 10). For simplicity, we use the term "temporal discounting" to refer to these related concepts and measures, such as time perspective, consideration of future consequences, impulsivity, and future-/present-orientation. Measures of temporal discounting have been related to many BCD behaviours, and we review this literature in section 5. At this point, it suffices to say that much of the BCD may result from socioeconomic differences in trade-offs between present and future. Support for this idea is reflected in the way that attitudes and perceptions vary with SES: People of lower SES have been found to be more impulsive, less future-oriented, and more pessimistic about their futures than those of higher SES (Adams & White 2009; DeWit et al. 2007; Robb et al. 2009). For example, one study examined households in hundreds of Vietnamese villages and found that people in higher-income households and in wealthier villages were more patient (Tanaka et al. 2010). Similar associations between time preference and wealth and education have even been documented in the small-scale horticultural-forager societies of the Tsimane Amerindians (Kirby 2002).

Why might socioeconomic differences be evident in temporal discounting? The literature presents a variety of views on the question. Some view impulsivity as the result of "deficient inhibitory processes," implying that impulsivity is pathology (Bari & Robbins 2013; Dalley et al. 2011). Others suggest that stress and negative affect cause "short-sighted" decision making, implying that present-oriented decisions are the result of poor judgement or impaired cognition brought on by stress (Haushofer & Fehr 2014). By contrast, we, among others, argue that socioeconomic differences in temporal discounting may represent a contextually appropriate response to factors associated with SES, which we discuss in sections 2.2–2.4. By describing behaviours as "contextually appropriate," we wish to imply that they are understandable given the context in which people are operating. In this particular case, we argue that the behaviours of the BCD represent contextually appropriate responses to experiences commonly associated with socioeconomic hardship – an interpretation that we refer to as the contextually appropriate response perspective.

2.2. Personal control and the ability to influence the future

People of lower SES are by definition poorer than those of higher SES (Braveman et al. 2005) and tend to have lower social and political influence. This lack of wealth and influence may limit their ability to affect future outcomes (Infurna et al. 2011). At the psychological level, the inability to influence the future is experienced as a lesser sense of personal control. We henceforth use "personal control" to refer to both the actual ability to influence future outcomes and the perception that one has that ability (although we discuss issues relating to the concordance between perceptions and reality in sects. 7 and 8.4).

Lower SES may reduce personal control in several ways. Most obviously, wealth enhances the ability to purchase solutions to problems. For example, residents in a deprived community may face a range of hazards, such as pollution, unsafe housing, or violent crime. They are less able to control their exposure to such hazards if they cannot afford to repair their housing or move to a safer neighbourhood. In addition, higher SES brings with it a variety of social and institutional connections and resources that can help alter outcomes. Several decades' worth of empirical studies demonstrate associations between measures of SES and both perceived and actual personal control (Bosma et al. 1999; Gilmore et al. 2002; Infurna et al. 2011; Kiecolt et al. 2009; Lachman & Weaver 1998; C. Lee et al. 2009; Lundberg et al. 2007; Mirowsky et al. 1996; Poortinga et al. 2008; Ross & Wu 1995; Turner & Noh 1983; Umberson 1993; Whitehead et al. 2016).

There are known SES gradients in mental health, with lower-SES people suffering from a greater burden of problems, such as depression, anxiety, and schizophrenia (Hudson 2005; Muntaner et al. 2004; Stewart Williams & Cunich 2013). We do not discuss these associations in detail, because they are beyond the scope of our article. However, we note that the phenomenon seems unsurprising when you consider that lower-SES people frequently struggle with a range of problems that are, or are perceived to be, beyond their control.

2.3. The specific example of control over mortality risk

Limited personal control may include a restricted ability to ensure that returns on investments made in the present, for payoffs in the future, will be received. The most extreme example of a factor limiting payoffs of investments for the future is death: A lack of control over one's own risk of

death can limit one's chance of being alive to spend saved money, to have children in future years, to reap the benefits of healthy living, or to see any other future outcome at all. A risk of death that is beyond one's control can be termed "extrinsic mortality risk" (see Glossary – sect. 10).

Let us consider the role of extrinsic mortality risk in SES differences in health behaviours. If people of lower SES feel that they are likely to be killed by something they cannot control, it would make sense for them to invest less effort in looking after their health (the part of their mortality risk that they *can* control). The reason is that as the component of mortality risk that one cannot influence becomes larger, the odds of living long enough to see the rewards of healthy living diminish (elsewhere, we have called this the uncontrollable mortality risk hypothesis; Pepper & Nettle 2014a).

A simplified example of the logic is as follows: If you live in a neighbourhood beset by violent crime, your risk of being a victim of homicide is relatively high. Again, if you are poor and cannot afford to move to a better neighbourhood, this risk is beyond your control. Under such circumstances, there may seem little point in quitting smoking or eating healthy foods, because you may not live to see the benefits of these actions. A quote from a young offender from Atlanta illustrates the severity of this problem in some deprived neighbourhoods: "Where I'm from you never know if you gonna live one minute to the next. It's like a war out there. People die every day. You can go to sleep and hear gunshots all night man, all night" (Brezina et al. 2009). This attitude may seem exaggerated, but evidence shows the existence of strong SES gradients in mortality due to homicide (Cubbin et al. 2000; Redelings et al. 2010; Shaw et al. 2005), assault, and other violent crimes (Leyland & Dundas 2010; Markowitz 2003).

Furthermore, violent crime is not the only factor that might make mortality risk less controllable for the poor. Even when unhealthy behaviours are controlled for, lower-income populations still suffer an elevated risk of mortality relative to higher-income populations (Lantz et al. 1998). This disparity suggests that lower-SES individuals face mortality risks that do not result from their behaviour – these risks are extrinsic. A systematic review by Bolte et al. (2010) examined environmental inequalities among children in Europe, offering examples of specific risks to which the poor are more exposed. They found that lower-SES children suffer from multiple and cumulative exposures to health hazards, including traffic-related air pollution, noise, lead, environmental tobacco smoke, inadequate housing, and unsafe residential conditions.

At first glance, it may seem that the absolute levels of extrinsic mortality risk associated with deprivation in developed nations cannot be sufficient to cause meaningful differences in incentives for future-oriented behaviour. However, Nettle (2010b) used a mathematical model to make the case that increases in uncontrollable mortality at low absolute rates (1–3%) could be expected to lead to marked shifts in health behaviour (see Fig. 1 and sect. 3.1 for more details). The model showed that inequalities in control over exposure to mortality hazards need not be great to generate clear socioeconomic differences in health behaviours. Nonetheless, there are marked inequalities in mortality by certain causes. For example, in the United Kingdom between 1996 and 2000, people living in the poorest 10% of neighbourhoods were more than

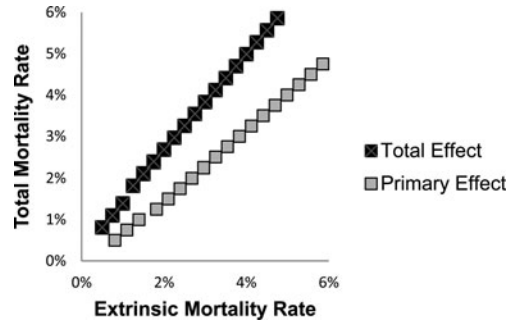

Figure 1. The additive effect of extrinsic and intrinsic mortality risks. As extrinsic mortality risk increases, the predicted total mortality rate increases more rapidly, through a combination of the primary effect of extrinsic mortality and the secondary effect of disinvestment in health as a response to extrinsic mortality risk (intrinsic mortality risk). Total mortality risk assumes the optimal amount of health-protecting behaviour for maximising Darwinian fitness at that level of extrinsic mortality, given a negative-exponential relationship between health behaviour and intrinsic mortality risk. (Reproduced from Nettle 2010b.)

5.7 times more likely to be murdered than those living in the wealthiest 10% (Shaw et al. 2005). Given the aforementioned insight from Nettle's (2010b) model, we might expect initial inequalities of such a magnitude to generate substantial SES differences in health behaviours.

Some of our recent empirical findings support the idea that limited control should cause disinvestment in health. In a sample of North American adults we surveyed, those of lower SES perceived a greater portion of their personal mortality risk as being extrinsic. That is, they believed that their mortality risk would be relatively unaffected by their making greater efforts to look after their health (Pepper & Nettle 2014b). Moreover, we found that the degree to which mortality risk was perceived as extrinsic was the best predictor of how much effort in looking after health they reported making.

Lawlor et al. (2003) put forward a similar hypothesis. They examined trends in smoking prevalence among the different social classes over time (1948–1999) and found that, once the health risks of smoking became widely known, there were marked decreases in smoking in the upper social classes, but not in the lower classes. They suggested that this was because the lower social classes were still suffering a substantial burden from non–smoking-related morbidity and premature mortality that reduced their incentive to forgo the otherwise appealing activity of smoking. Their idea is supported by evidence that smoking is more prevalent among occupational groups who are more exposed to hazards in the workplace, while it is less prevalent among those who are exposed to fewer hazards at work (Sterling & Weinkam 1990).

It is not only health behaviour that should change in response to extrinsic mortality risk. People who have a limited ability to ensure their own longevity should operate on a shorter time scale with respect to a range of outcomes (Daly & Wilson 2005; Kruger et al. 2008), and the evidence suggests that they do. Analyses from a Global Preferences Survey of 80,000 people in 76 countries show that people living in countries with longer average life expectancies are more willing to wait for future rewards (Falk et al. 2015). People living under conditions of high

extrinsic mortality have children sooner than those living under conditions of low extrinsic mortality (Quinlan 2010; Störmer & Lummaa 2014; Wilson & Daly 1997). Across countries, there are strong associations between mortality rates and ages at first birth (Bulled & Sosis 2010; Low et al. 2008; Low et al. 2013). Similar patterns can be seen among individuals within countries and cities (Nettle 2010a; Quinlan 2010; Wilson & Daly 1997), and there are associations between parental investment and mortality risk (Quinlan 2007). One study even examined several behaviours from the BCD simultaneously. It showed that the scheduling of marital and reproductive behaviours and the attainment of education were associated with life expectancy (Krupp 2012).

Experiences indicative of personal mortality risk also appear to influence the extent to which people value future financial outcomes. Exposure to violence is associated with financial future discounting (Ramos et al. 2013). Earthquake survivors discount future rewards more steeply than controls (Li et al. 2012), and experiences of close bereavement are associated with greater financial future discounting (Pepper & Nettle 2013).

2.4. Personal control over factors other than mortality risk

We have made the case that a behavioural constellation is associated with deprivation, which is characterised by a tendency to prioritise more immediate outcomes above distant ones (sect. 2). We have suggested that people of lower SES prioritise the present, because they are less able to ensure that they will receive deferred rewards (sect. 2.2). This hypothesis illustrates the link between SES, control, and temporal discounting. We have used extrinsic mortality risk as an illustrative example, partly because mortality is the most definitive future-limiting factor (sect. 2.3). Moreover, extrinsic mortality risk has been extensively studied in evolutionary theoretical models, principles from which can be used to deepen our understanding of socioeconomic differences in behaviour (see sect. 3).

Although we have emphasised the role of extrinsic mortality risk, it is important to note that socioeconomic differences in control over other future-limiting factors are also important. For example, deprived neighbourhoods have lower levels of trust, cooperation, and social capital (Drukker et al. 2003; Drukker & van Os 2003; Hill et al. 2014; Schroeder et al. 2014). Their residents may feel less able to rely on others to deliver on their promises of future rewards. They should therefore be less willing to accept delays on social returns, because a delay contains an inherent risk that the future reward will not be received. Indeed, a large international survey recently found that people who are trusting of others feel safe in the area they live in, have confidence in their local police force, and are also more patient (Falk et al. 2015). The idea that trust influences temporal discounting is further supported by some experimental evidence: After having interacted with an experimenter who failed to deliver on a promise, children were less willing to wait for a larger reward than those who had interacted with a reliable experimenter (Kidd et al. 2013). Similarly, vignette studies have shown that people are less willing to wait for rewards from characters described as being untrustworthy or from people whose face images had been manipulated to make them appear less trustworthy (Michaelson et al. 2013).

When it comes to financial decisions, having a low income – in itself a relatively uncontrollable factor – should interact with other future-limiting factors to decrease the incentive to save for the future: If one has less money available to save, it will take longer to save for any given purpose, making smaller-sooner rewards more achievable than distant saving goals and thus exacerbating the effects of temporal discounting on saving. Evidence suggests that having capital does indeed make it easier to accumulate wealth (Borgerhoff Mulder et al. 2009; Bowles et al. 2010; Piketty 2015; Piketty & Saez 2014). Thus, those who start out with less capital are less able to accumulate wealth and are therefore less incentivised to save for a future that may not come.

2.5. Positive versus negative outcomes

We have argued that a combination of future-limiting factors, including extrinsic mortality risk, may account for the BCD, which is characterised by the prioritisation of the present over the future. Many of our examples have involved the expected effect of future-limiting factors on the willingness to wait for rewards. However, it should also be noted that the same principle applies to negative outcomes.

People should be less worried about accruing debt if they believe there is a limited chance that they will ever have to repay it. Similarly, they should be less concerned about indulging in activities that are rewarding in the short term, and damaging in the long term, if they think that they may not be around to see the negative consequences of those actions in the future (Daly & Wilson 2005). For example, studies have found that greater temporal discounting and decreased consideration for future consequences are associated with health-risking behaviours and criminal activity, activities that entail potential negative future consequences in terms of poor health and potential punishment (Dassen et al. 2015; Nagin & Pogarsky 2004; Reimers et al. 2009).

If people expect their futures to be bleak regardless of what they do in the present, avoiding actions with potential negative future consequences may seem pointless. Indeed, young people who express feelings of hopelessness and of being futureless also report more violent and aggressive behaviour, substance use, and sexual risk taking (Bolland 2003; Brezina et al. 2009).

Experiments have also been used to manipulate participants' considerations of future consequences and, thereby, behaviours that could result in future punishment. In one experiment, participants who had written a letter to their future selves were less likely to agree to hypothetical illegal actions. In another, those who interacted with digitally created versions of their future selves in a virtual reality environment were less likely to cheat in a subsequent trivia quiz when given the opportunity (van Gelder et al. 2013).

3. Theoretical models that augment our understanding of the BCD

In this section, we review models from evolutionary biology that are relevant to the BCD. Many of these models embody principles that were originally used to understand

the selective forces leading to the evolution of traits over generations. However, the same principles can be applied to enhance our understanding of how behaviour is shaped by people's environments within their lifetimes. Thinking about the predictions of these models can generate a deeper understanding of the effects of deprivation throughout the life course. In section 3.1, we discuss models of extrinsic mortality and ageing. In section 3.2, we outline models of feedback and feedforward processes, which illustrate how small initial differences can generate larger eventual inequalities.

3.1. Models of extrinsic mortality and ageing

Evolutionary theoretical models have comprehensively examined extrinsic mortality risk as a factor in ageing and life histories (Medawar 1952; Stearns 1992; Williams 1957). Models of ageing identify extrinsic mortality as a factor that limits the energetic investment that should be made in physiological repair (Kirkwood 1977; Kirkwood & Austad 2000). They also predict earlier reproduction in response to extrinsic mortality risk (Kirkwood & Rose 1991; Westendorp & Kirkwood 1998). These predictions are supported by empirical evidence: Mammals that suffer high levels of natural mortality mature earlier, start reproducing sooner, have shorter gestation periods, and give birth to larger litters of smaller offspring (Harvey & Zammuto 1985; Promislow & Harvey 1990). Experimental evolution studies in fruit flies show that if adult mortality rates are manipulated in the laboratory, shorter life-spans and earlier peak fecundity evolve (Stearns et al. 2000).

Most models of ageing and life histories examine how the strategies of organisms should evolve over generations. However, the logic of these models inspired the prediction that people should, within their lifetimes, calibrate their behavioural investments in the future, including health efforts, in response to perceived extrinsic mortality risk (e.g., Chisholm et al. 1993; Nettle 2010b). Such models assume that natural selection has endowed organisms with the ability to adjust their behaviours plastically in response to their environments. This assumption is supported by evidence that human reproductive strategies vary systematically with levels of local mortality risk (e.g., Chisholm et al. 1993; Lawson & Mace 2011; Low et al. 2008; Nettle 2011; Nettle et al. 2011) – associations that change so rapidly, they are not plausibly a result of genetic selection.

We have found support for the idea that people may alter their behavioural investments in health in response to perceived extrinsic mortality risk (Pepper & Nettle 2014a; 2014b). Evolutionary theoretical models have also shown that physiological investment in health may be calibrated within an individual's lifetime, based on rates of extrinsic mortality (Cichoń 1997). That is, exposure to extrinsic mortality risk may lead to double disinvestment, with the body allocating fewer resources to physiological repair and reducing behavioural investments in health. This disinvestment relates to the question of health inequalities, because it has been proposed that people of differing SES may age at different rates (Adams & White 2004). We propose that SES differences in exposure to extrinsic mortality risk drive differences in both physiological and behavioural investments in health, leading to this apparent socioeconomic difference in pace of ageing.

If extrinsic mortality risk triggers a double disinvestment in future health, through behavioural and physiological pathways, then it could generate a composite effect. Moreover, if there are initial inequalities in exposure to extrinsic mortality risk, these could become summed with the additional mortality risk generated by disinvestment in health (the intrinsic mortality risk – see Glossary, sect. 10) to give a larger total mortality risk (Nettle 2010b). Figure 1 illustrates this idea. Assuming a negative-exponential relationship between health behaviour and intrinsic mortality risk, and a relatively weak trade-off between health behaviour and other activities, a 1% level of extrinsic mortality risk would generate a disinvestment in health that increases total mortality risk to 1.39%. At a greater, but still realistic, 5% level of extrinsic mortality, the total mortality risk, given optimal health behaviour (as dictated by the model), would be 6.15%. The higher the initial level of extrinsic mortality risk, the greater the secondary effect, and the more the problem is compounded.

3.2. Models of feedback and feedforward processes

In section 3.1, we explained how small initial differences in exposure to extrinsic mortality risk may be amplified, generating larger eventual disparities in mortality through the combined effects of extrinsic mortality risk and the intrinsic risk it causes via behavioural and physiological disinvestment in the future. Although they are important, these principles alone are unlikely to be sufficient to explain the observed magnitude and persistence of socioeconomic gradients in behaviour. We also need to understand how individual decisions have consequences that feed back into the future decision space, leading to the perpetuation and magnification of small initial differences. Fortunately, principles from evolutionary theory can also be brought to bear on these processes.

A simple illustration is as follows. Let us assume that unhealthy behaviours do some amount of irreparable damage to health. Once this damage is done, it is, technically, extrinsic – that is, damage done in the past may not be reversible by healthy behaviour in the present. This irreparable damage, like other sources of extrinsic mortality risk, limits the benefit of healthy behaviour, which leads to more unhealthy behaviour, which does more damage. Thus, healthy behaviour is further disincentivised, and the cycle compounds itself (Fig. 2). Given such a dynamic, one could take two identical individuals, start their lives in environments with differing levels of extrinsic mortality risk, and then move them into identically benign environments but still see diverging outcomes. Such positive feedback loops are often identified in theoretical models from behavioural ecology (e.g., Luttbeg & Sih 2010; Sozou & Seymour 2003).

These feedback loops might cause inequalities in early life to become embedded to the point that later intervention has little impact in terms of closing the life-expectancy gap. Consistent with this possibility, much evidence suggests that early-life circumstances are important for determining health in later life (e.g., Aizer & Currie 2014; Blackwell et al. 2001; Case et al. 2005; Haas 2008; Miller et al. 2011; Nettle 2014; Palloni et al. 2009). The results of longitudinal studies even suggest that early-life experiences are related to markers of biological ageing: For example, traumatic childhood experiences have been

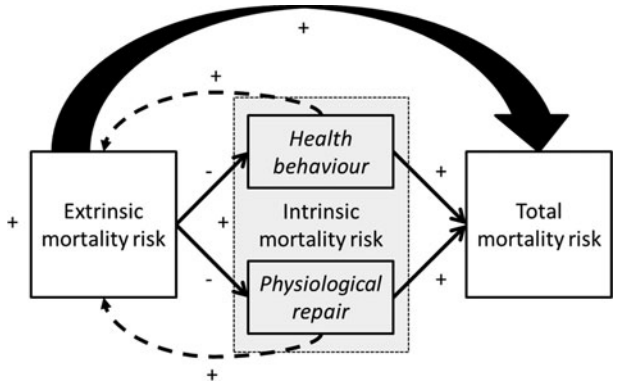

Figure 2. The hypothesised dynamic between extrinsic mortality risk, intrinsic mortality risk (resulting from behavioural and physiological disinvestments in health), and total mortality risk. Extrinsic mortality risk contributes directly to total mortality risk. Extrinsic mortality risk also decreases the optimal behavioural and physiological investments in health. Any disinvestment in health increases the level of intrinsic mortality risk, thereby contributing to total mortality risk. Assuming that disinvestments in health leave some amount of irreparable damage, they will feed back into extrinsic mortality risk, increasing it and continuing the feedback loop.

linked to increased telomere erosion (Revesz et al. 2016; Shalev et al. 2012).

Another principle from theoretical models that can be applied to the BCD is that of constraint. Individuals who start out in a poor state, economically or physiologically, may appear to make inappropriate choices, when in fact they are "making the best of a bad job" (Luttbeg & Sih 2010). In a theoretical model of adaptive behavioural syndromes, individuals who start off in better states always do better than those who start in poorer states, even though all individuals make appropriate decisions, given their starting points (Luttbeg & Sih 2010). This result emphasises the fallacy of assuming that the appropriate strategy is the same for all individuals – that is, what is optimal for one individual might be suboptimal for another. The concept of making the best of a bad job is important for the two hypothetical individuals mentioned above. Although their adult environments are identical, they may still display different health behaviours and experience different health outcomes, because they had different early-life experiences. Their initial decisions, which were optimal (in the theoretically modelled sense) given the constraints they faced at the time, became embedded as irreparable damage, altering what is optimal for them to do later, relative to those who had better starts. In other words, constraints breed constraints.

The feedback loops that we have described can also be amplified over generations. Those who start out in poor conditions may adopt a strategy of early reproduction with limited parental investment. Even though this might be the best that they can do under the circumstances, it nonetheless may mean that their children start out in poorer states than those of their relatively advantaged peers. This initial disadvantage will, in turn, condition their behavioural decisions and health risks, passing the disadvantages across the generational boundary and perpetuating the cycle. A review by Aizer and Currie (2014) summarised data in support of this idea; they found that maternal disadvantage translated to poorer child health through a range of mechanisms, including poor maternal health, poor maternal health behaviour, and exposure to harmful environmental factors.

We have reviewed a number of principles from evolutionary models of ageing (the result of physiological disinvestment in future health) that could be applied to the problem of individual differences in health behaviour (behavioural disinvestment in future health). First and foremost, we have emphasised the idea that extrinsic mortality risk should reduce investment in future outcomes, including health. We have also reviewed the ideas that small initial differences can lead to large eventual disparities and that feedback loops are at work and can operate intergenerationally. These principles can help us understand how socioeconomic inequalities in health and longevity can become embedded and amplified through differing rates of ageing and unhealthy behaviours. The differences in life expectancy that are generated through these additive pathways and feedback loops may drive the BCD.

4. The mechanisms involved in the BCD

A central feature of evolutionary perspectives on behaviour is that they make the distinction between ultimate and proximate causes (Mayr 1961; Tinbergen 1963). "Ultimate explanations" clarify why a trait or behaviour should occur in a specified population and environment, given the payoffs to that trait or behaviour in that environment. As such, the contextually appropriate response perspective we have discussed so far is an ultimate explanation. However, ultimate explanations do not preclude – and, indeed, require – "proximate explanations," which detail how those contextually appropriate behavioural responses are generated within the individual. For example, proximate explanations might identify the psychological or neural mechanisms involved in generating patterns of behaviour. Proximate and ultimate explanations are complementary (Scott-Phillips et al. 2011). Furthermore, it is possible to outline multiple proximate causes, which may seem distinct but are all part of the same process of delivering the contextually appropriate response. For example, biological mechanisms (such as endocrinological or neurological processes) will underlie mechanisms conceptualised at the psychological level (such as impulsivity), which, in turn, deliver differences in behaviour in response to the environment. In this section, we discuss some of the psychological (sects. 4.1–4.3) and biological (sects. 4.4 and 4.5) processes that might be considered proximate mechanisms underlying the BCD.

4.1. The BCD can be delivered by both reflective and automatic psychological processes

So what psychological processes might underlie the BCD? Perhaps people are conscious of their own future prospects and deliberately alter their behaviour to reflect them. In a study of low-income American teen mothers, Geronimus (1996) found that despite the stigma attached to teen motherhood, the young women appeared to be choosing to have children sooner. The teens perceived that women should have children earlier because their health would not be

good enough to withstand pregnancy and motherhood later. This account contrasts with the common perception that teen pregnancies are the result of whim or ignorance.

In their article "Might Not Be a Tomorrow," Brezina et al. (2009) explored the concept of futurelessness as a factor in youth crime and violence, supported by interviews with young offenders. Their findings highlighted the idea that these young offenders pursued immediate rewards because they did not expect to live long and saw planning for the future as futile: "I say f*** tomorrow. It's all about today. Might not be a tomorrow. Might get shot. Might get hit by a bus. So get it now. Now, now, now. Next week might as well be next century. F*** next week. F*** tomorrow." Similarly, Bolland (2003) found that young people in deprived urban neighbourhoods, who did not expect to live long, saw little point in planning for their futures and tended to engage in health-risking behaviour, such as substance abuse.

Bulley et al. (2016) have written about the role of episodic foresight in intertemporal choice. They proposed that explicit simulations of potential future outcomes trigger emotions that can either motivate people to forgo immediate rewards in favour of longer-term goals when the future looks promising or foster a preference for immediate outcomes when the future is anticipated to be dangerous, hostile, or uncertain. This concept of simulations of the future generating differential motivation might help us better understand socioeconomic differences in success when making lifestyle changes. For example, evidence suggests that although desire to quit smoking and use of smoking cessation tools do not differ by social class, quitting success does (Kotz & West 2009). This discrepancy in success may result from differences in motivation, based on different expectations of the future, rather than from differences in understanding regarding the risks of smoking (attempting to quit implies an understanding that smoking is detrimental to health).

In addition to conscious deliberation, there may be more automatic and implicit adjustments of behaviour in response to cues of extrinsic risk. In experimental tests, we found that if people were primed with information suggesting that prevailing mortality risks were controllable, they were more likely to choose a healthy snack than an unhealthy one. However, those participants who chose a healthier snack did not report a greater intention to eat healthily than participants who did not (Pepper & Nettle 2014a). This outcome suggests that the effect may be due to an implicit, automatic response rather than an explicit, reflective one. This finding is consistent with prior evidence suggesting that some health-related decisions involve implicit, automatic processes (Gibbons et al. 2009; Sheeran et al. 2013). Another interesting implication of this finding is that a BCD behaviour can be altered using a brief psychological manipulation. Thus, although unhealthy behaviours may be partly driven by embedded beliefs, behaviour may remain relatively malleable in some cases, with people responding immediately to new information about their prospects.

4.2. Socioeconomic differences in how immediate rewards are valued

We have reviewed the idea that socioeconomic differences in expectations of the future may affect the extent to which people are motivated to forgo more immediate rewards in pursuit of longer-term goals. One of the ways by which this differential motivation emerges may be through SES differences in how rewards are valued. For example, high-fat and high-calorie foods may be intrinsically more rewarding to people of lower SES. Indeed, studies support the idea that individual differences exist in neural responses to food rewards and food images (Beaver et al. 2006; Stice et al. 2008), and general reward sensitivity has been related to tendencies to be overweight or obese and to food cravings in people of a healthy weight (Franken & Muris 2005; Volkow et al. 2011). However, there has been limited investigation into the existence of socioeconomic gradients in sensitivity to food rewards or to other substances, such as tobacco products or alcohol. We know of one study that showed SES differences in striatal dopamine receptor availability, variation in which has been linked to susceptibility to drug addiction (Wiers et al. 2016). Further, studies of this sort would enhance our understanding of the mechanisms by which SES differences in health behaviour emerge.

Food rewards are not the only more immediate gains that may be valued differently depending upon SES: Shorter-term gains in social status may also be valued differently. Wilson and Daly (1985) explained that because high-status males, who can offer more resources and protection to children, tend to monopolise access to reproductive opportunities, men have evolved to compete for status – a long-standing idea in the evolutionary literature (Bateman 1948; Williams 1966). They proposed that for young, single, unemployed men "whose present circumstances are predictive of reproductive failure," violent conflict and other forms of risk taking may be the only feasible routes to increased status. They supported this idea with a catalogue of evidence showing that young, unemployed, unmarried men are disproportionately represented among homicide perpetrators and victims, and that the majority of such homicides result from altercations over deference and "face" (Daly & Wilson 1988; 2001; Daly et al. 2001; Wilson & Daly 1985; 1998). Wilson and Daly showed that indicators of inequality (related to the intensity of male-male conflict for status) are good predictors of violence, a finding subsequently supported by studies from various other authors (Daly et al. 2001; Elgar & Aitken 2011; Jacobs & Richardson 2008; Pickett et al. 2005; Wilson & Daly 1997). Furthermore, they demonstrated that violence was more common in Chicago neighbourhoods where life expectancies (cause-deleted for homicide) were shorter (Wilson & Daly 1997), hypothesising that steeper future discounting, generated by shorter life expectancies, tends to lead competitions over status to escalate more readily. This evidence suggests SES differences in the extent to which status and respect are valued and sought out. Indeed, qualitative studies discussed by Anderson (1994) have emphasised the importance of the desire for respect in driving violence in deprived neighbourhoods, an idea supported by quantitative studies (Brezina 2004). This evidence also offers the understanding of a route by which perceptions of inequality may contribute to the feedback loops we discussed in section 3.2: If the combination of inequality and diminished future prospects leads to increased violence in an area, this violence will further decrease local life expectancies, reducing focus on the future and compounding the problem.

4.3. Social learning processes and the BCD

What of the idea that people may act impulsively because impulsive behaviours are a lower-SES social norm? Although evolutionary processes have generated our capacity for social learning, we consider social transmission itself to be a proximate mechanism by which behaviour is transmitted and sustained. Peers may support healthy behaviour or encourage unhealthy behaviour in different social settings (Christakis & Fowler 2007; 2008). More subtly, people learn socially, using cues about the behaviour of others to guide their own decisions (Keizer et al. 2008; Schroeder et al. 2014; Schultz et al. 2007). Once established, socioeconomic differences in behaviour may be further perpetuated by specific social norms (Nettle 2015, p. 117). However, as we have argued elsewhere, this alone is an incomplete explanation. It elaborates on how patterns of behaviour are sustained over time in particular social groups through social norms and social learning, but it does not explain why those specific social groups initiate those particular patterns of behaviour in the first place, such that those patterns of behaviour become available as social norms. However, the ultimate explanation we have outlined fills this gap (see also Pepper & Nettle 2014c).

4.4. Biological mechanisms in the BCD

Stress has been put forward as a major mechanism by which poverty "gets under the skin." We have talked about how personal control influences behaviour, and control is also an integral element of some definitions of stress. For example, Miller et al. (2011) defined stress as "an umbrella term, meant to capture times when a person has been exposed to a stimulus and judged it to be a threat he or she cannot manage." As such, the BCD could be viewed as a behavioural stress response.

Stresses may become embedded by many routes, producing differences in behaviour. Miller et al. (2011) suggested that stressors in early life generate proinflammatory tendencies, exacerbated by poor health behaviours, driving chronic inflammation and thereby later-life disease. They proposed three specific mechanisms for the embedding of early-life stresses: (1) epigenetic changes, (2) posttranslational modification, and (3) tissue remodelling. Their proposal is supported by evidence showing that people of lower childhood SES have higher levels of circulating c-reactive proteins, greater inflammatory cytokine responses to ex vivo microbial challenges, and higher circulating levels of interleukin 6 – all indicators of an increased proinflammatory response (Loucks et al. 2010; Miller et al. 2009; Taylor et al. 2006). Furthermore, blood DNA methylation profiles are more strongly associated with childhood than with adult SES and with earlier, but not later, childhood adversity, supporting the idea of an epigenetic pathway in the embedding process (Borghol et al. 2011; Esposito et al. 2016).

The effects of stress can also be embedded through endocrine pathways, such as the hypothalamic–pituitary–adrenal (HPA) axis. A key product of this axis is cortisol, a hormone that peaks in response to stressful experiences and has wider cardiovascular, immunological, and metabolic effects (Gustafsson et al. 2010). Studies have linked childhood SES and early-life stress to average cortisol output, diurnal cortisol patterns, and cortisol responses to acute stress tests (Gustafsson et al. 2010; Hajat et al. 2010; Lupie et al. 2001; Wright & Steptoe 2005). For example, one study found that 12-year-old children who had been bullied exhibited blunted cortisol responses to psychosocial stress tests and had more social and behavioural problems than did their peers who had not been bullied (Ouellet-Morin et al. 2011).

Studies have also identified neural mechanisms by which experiences of deprivation might produce behavioural differences. Brito and Noble (2014) reviewed the literature and summarised a number of studies showing structural differences in the brain by SES. These studies reported mixed findings, but they showed SES differences by a range of measures, including the volumes of the cerebellum, hippocampus, amygdala, and frontal and parietal lobes. Such findings suggest that factors associated with SES may have effects on brain development, but it is not clear how these effects link to brain function. Only a few studies have examined SES differences in neural responses to tasks and stimuli. One functional magnetic resonance imaging (fMRI) study showed that the SES of participants' parents predicted the participants' amygdala reactivity in response to threatening facial expressions (Gianaros et al. 2008). Another showed that subjective SES moderated an association between neural responses to perceived pain in others (a measure of empathy) and subsequent charitable donations (Ma et al. 2011). However, with the exception of one study showing SES differences in a neural correlate of drug addiction (Wiers et al. 2016), studies have not examined the neural correlates of BCD behaviours. To further understand the neural mechanisms of the BCD, it would be useful to examine socioeconomic differences in neural responses to decisions involving present-future trade-offs. Such work could build on studies that have already investigated the neural correlates of temporal discounting (Hariri et al. 2006; Kim et al. 2012; Li et al. 2012).

In section 3.1, we discussed evolutionary theoretical models that suggest extrinsic mortality risk should drive physiological disinvestment in longevity. Some of the mechanisms we have reviewed have been considered in this light. For example, cortisol responses to acute threats have been conceptualised as reflecting the trade-off between investing in long-term survival and other priorities, such as reproduction (Harris & Saltzman 2013; Wingfield & Sapolsky 2003). Others of the mechanisms we have reviewed, such as chronic inflammatory responses, may simply result from socioeconomic differences in damage accumulated through various environmental insults. Further research is needed to develop an understanding of the biological mechanisms involved in response to perceived extrinsic threats.

In section 3.2, we suggested that the feedback loops embedding the effects of deprivation can be amplified over generations. Godfrey et al. (2010) have already reviewed evidence on intergenerational transmission of metabolic disease, outlining the roles of developmental and epigenetic mechanisms. Studies have also investigated mechanisms by which the effects of maternal stress can be transmitted to children via the intrauterine environment. For example, stress during pregnancy predicts telomere length (a biomarker of ageing) in children after they are born. Similarly, when cortisol is experimentally injected

into chicken eggs, the chicks have shorter telomeres than do the control birds (Entringer et al. 2011; Gluckman & Hanson 2004; Haussmann et al. 2012).

4.5. Heritability, differential susceptibility, and the BCD

So far, we have focussed on the effects of environmental factors that limit control over the future, thereby restricting the benefit of investing in long-term outcomes. The results of the behavioural experiments reviewed in section 8.5 support the idea of a causal link in this direction. However, reverse causality is also a possibility. What if being present-oriented leads people to be poor and therefore exposed to more influences beyond their control? Then we must ask, if it is not the experience of adversities beyond personal control, what causes initial individual differences in temporal discounting? An obvious answer is that there may be genetic drivers of temporal discounting. Mitchell (2011) reviewed the literature on genetic influences on temporal discounting, reporting only one study using humans. This study was by Anokhin et al. (2011), who examined temporal discounting in twins and reported a stronger association between choices in monozygotic than dizygotic twins, suggesting a possible genetic component to temporal discounting.

Genetic contributions to traits, however, can be obscured by environmental effects, particularly in those of lower SES. For example, Turkheimer et al. (2003) found that, among lower-SES families, a large amount of the variation in children's intelligence quotients (IQs), could be accounted for by environment, with almost none of the variation being attributable to additive variation in genotype. Conversely, in higher-SES families, a large portion of the variation in child IQ could be accounted for by genetics, with almost none of it being explained by environment. These results suggest that although good conditions allow children to reach their full potential (at least in terms of IQ), children living in poverty are much more heavily constrained by their environments than by any constitutional limits.

A more complete understanding may therefore be gained by examining the role of gene-environment interactions in SES differences in temporal discounting. Little work has been done in this area, but one study by Sweitzer et al. (2013) examined the dopamine receptor D4 (DRD4) genotype as a moderator of the effect of childhood SES on temporal discounting. Although they found direct effects of both childhood and adulthood SES on temporal discounting, only childhood SES had effects in interaction with the DRD4 genotype. Specifically, the experience of childhood socioeconomic disadvantage was associated with steeper temporal discounting in people with the DRD4 7-repeat allele. In absence of this allele, people who had grown up in lower-SES families discounted future rewards in a similar manner to those who had not experienced childhood socioeconomic disadvantage and did not have the DRD4 7-repeat allele. Those who had grown up in relatively advantaged families and had the DRD4 7-repeat allele discounted future rewards even less than either their disadvantaged counterparts or those of either lower or higher childhood SES without the allele. This study is just one of a growing number examining the differential susceptibility of individuals to environmental effects (Belsky & Pluess 2009). Although more studies on specific factors, such as temporal discounting, are needed, findings of differential susceptibility more generally highlight the danger of simplistically assuming that such traits as temporal discounting cause a person's experience of poverty rather than are a product of it. For the majority of people, environmental influences, particularly in early life, play important roles, but the same environmental challenges may affect different individuals to different extents.

To conclude section 4, multiple proximate mechanisms can act in concert. People may make some deliberate, reflective choices, based on their perceived future prospects, but many of their responses may be automatic and unconscious. SES differences in behaviour may be delivered, in part, through SES differences in hedonic responses to rewards or in the motivation to pursue them. Patterns of behaviour may be perpetuated if people learn about their own life prospects from others, adopting the social norms of their communities. Stresses may become embedded through epigenetic, endocrine, and neural mechanisms, producing differences in physiology and behaviour. Genetic factors may moderate the effects of the environment. Yet none of these mechanisms are mutually exclusive. The BCD may come about by many proximate routes, delivering a contextually appropriate response to our ultimate cause – lack of control over future outcomes.

5. Agreement between the contextually appropriate response perspective and other approaches

As outlined in section 2.2, being of low SES, by definition, means having limited wealth and power. We argue that lower-SES people have restricted control over future-limiting factors, including the most definitive of future-limiting factors – extrinsic mortality risk. This experience should lead them to have low perceived control and to be more present-oriented – that is, low perceived personal control should be associated with steeper future discounting and more present-oriented behaviours. We have arrived at this prediction largely on the basis of evolutionary theory. However, researchers working in myriad traditions have converged on the finding that control and temporal discounting are associated with BCD behaviours. We now review some of this evidence.

The consumer behaviour literature has explored the role of temporal discounting in financial decisions. Perhaps unsurprisingly, future orientation increases the tendency to save for the future (Falk et al. 2015; Howlett et al. 2008; Jacobs-Lawson & Hershey 2005). Measures of perceived control, such as fatalism and locus of control (see Glossary – sect. 10), are also associated with tendencies to save funds for future use. Specifically, people who are more fatalistic or perceive themselves to have less control over the future less often save for the future (Perry & Morris 2005; Shapiro & Wu 2011). Perceived control can also have an impact at the household level: Households in which the reference person has a higher degree of perceived control save more in absolute terms, but also as a percentage of their income (Cobb-Clark et al. 2013).

Measures of temporal discounting are associated with educational attainment (Falk et al. 2015). Tendencies to discount future rewards are negatively associated with high school and college grades (Duckworth & Seligman 2006; Kirby et al. 2005; N. C. Lee et al. 2012). Being

future-oriented is associated with better academic engagement and performance in high school students (Brown & Jones 2004). Experimental interventions have even been aimed at increasing future orientation to improve educational and career outcomes in high school and college students (Marko & Savickas 1998). Similarly, locus of control has been related to educational outcomes. Children with greater perceived personal control show better educational attainment, independent of other factors, such as SES and their parents' level of interest in their education (Barón 2009; Flouri 2006). Finally, the control-related concept of self-efficacy has been found to predict students' educational engagement, aspirations, and attainment (Zimmerman 2000).

The literature on control beliefs and reproductive timing is sparse. One study found that adolescents who reported greater hopelessness, including agreement with the statement "I do not expect to live a very long life," were also more likely to have a child or to report trying to have one (Bolland 2003). Relatedly, there is evidence regarding locus of control and sexual behaviour. Having an internal locus of control (see Glossary – sect. 10) has been related to increased contraceptive use and a decreased likelihood of becoming an unmarried parent (Wallston & Wallston 1978).

Literature on the links between temporal discounting and health behaviour is more readily available. Adams (2009) has reviewed evidence showing that people with a greater future time perspective are less likely to be smokers and, if they do smoke, to have more success in quitting. Several studies have found that measures of temporal discounting, including consideration of future consequences, are associated with eating behaviours, body mass index, and being overweight or obese (Adams & Nettle 2009; Adams & White 2009; Borghans & Golsteyn 2006; Price et al. 2013; Weller et al. 2008). One study found that measures of temporal discounting predicted reported tobacco, alcohol, and drug use; exercise frequency; eating breakfast; and use of seatbelts (Daugherty & Brase 2010). Another found that temporal discounting was a weak predictor of body mass index, smoking, and exercise behaviours when these outcomes were considered individually. However, it was a stronger predictor when the outcomes were aggregated (Chabris et al. 2008), suggesting that temporal discounting measures may simply indicate the strength of the present-future trade-off underlying clusters of behaviour more generally. This relationship between temporal discounting and health-damaging behaviour is also seen at the more extreme ends of the behavioural spectrum. For example, temporal discounting is associated with heroin and cocaine addiction (Kirby & Petry 2004; Kirby et al. 1999).

As a result of the associations between locus of control and health behaviour (Wallston & Wallston 1978), the concept of the locus of control has been extended to create the health locus of control (Wallston & Wallston 1981), generating a burgeoning literature. People with a greater belief in the influence of chance on health participate in fewer sporting activities, have fewer dental checkups, and less frequently enroll in health courses or otherwise seek out health information. Meanwhile, those who have an internal health locus of control consume less alcohol, smoke less, and are more likely to adhere to medical regimens (Grotz et al. 2011; Leong et al. 2004; O'Hea et al. 2005).

There is also a large volume of literature on the association between personal control and health outcomes more generally. After examining decades' worth of evidence from the Whitehall Studies, Marmot (2006) concluded that "autonomy – how much control you have over your life – and the opportunities you have for full social engagement and participation are crucial for health, well-being and longevity."

6. Distinctions between the contextually appropriate response perspective and other approaches

As we reviewed in section 5, there are many instances in which the contextually appropriate response perspective has converged upon similar conclusions to those of work based other on conceptual approaches. However, this perspective can generate subtly, but importantly, different predictions from other theories in some cases. Here, we illustrate this point using one example from the health communications literature (The extended parallel process model, sect. 6.1) and one from social psychology (terror management theory, sect. 6.2).

6.1. Distinctions between the contextually appropriate response perspective and the extended parallel process model

The extended parallel process model (EPPM) has been applied to "fear appeals," messages intended to change behaviour by inducing fear regarding health threats. The EPPM emphasises the importance of control-related concepts in eliciting behaviour change (Witte & Allen 2000). As such, it may not be immediately obvious that the contextually appropriate response perspective offers anything more than is already offered by the EPPM. We outline the difference here.

The EPPM states that if people perceive a severe threat and believe that they are able to respond adequately to that threat (personal efficacy), they should act to reduce the threat. However, if health messages highlight the threat without suggesting that the solution is effective (response efficacy), behaviour change is less likely to occur (Goei et al. 2010; Lewis et al. 2013; Witte & Allen 2000).

The EPPM focusses on the controllability of the specific aspects of health that are being communicated rather than on the controllability of mortality risk more generally. By comparison, we propose that perceived control over *total* mortality risk should alter motivation towards *any* behaviour with a delayed result, even behaviours unconnected to the specific risk that is the subject of the communication. For example, the EPPM would predict that the strength of your belief that you can control your risk of diabetes by modifying your diet would affect your motivation to eat healthily. The contextually appropriate response perspective would predict that if you believe you are unable to control your risk of death due to violent conflict, you should be less inclined to make an effort to eat healthily. A healthy diet is not recommended for reducing the threat of violence, yet the controllability of the latter risk influences the payoff to investing in the former. This is a subtle but valuable distinction: It suggests that fear appeals designed using the EPPM may fail to change

behaviour if their recommendations for mitigating specific risks only offer people small risk reductions against high background mortality risk.

6.2. Distinctions between the contextually appropriate response perspective and terror management theory

Terror management theory (TMT) suggests that people have an innate fear of death, which leads to a feeling of terror when they are made aware of their vulnerability (Greenberg et al. 1986). TMT proposes that when people are forced to contemplate their mortality (a state known as "mortality salience"), they will act to buffer their anxieties and suppress conscious thoughts of death. According to TMT, one of the ways in which people may buffer this death-related anxiety is by striving to "transcend death" through lasting achievements, including having children (Fritsche et al. 2007; Wisman & Goldenberg 2005; Zhou et al. 2009).

On the face of it, it may seem as though TMT makes similar predictions to our contextually appropriate response perspective. For example, both perspectives predict that an increase in awareness of mortality risk should increase the desire to have children and to have them sooner rather than later. However, the theories make different predictions regarding the effects of mortality on temporal discounting. According to Kelley and Schmeichel (2015), TMT predicts that mortality salience should engender a focus on the future by driving a desire to strive for immortality via lasting achievements. They contrasted this prediction with one often made in the evolutionary behavioural sciences (including the contextually appropriate response perspective), which is that mortality salience should make people more present-oriented. However, in making this contrast, Kelley and Schmeichel (2015) overlooked a key factor – the controllability of the mortality that is made salient. When they tested their prediction, using a standard mortality salience manipulation, they found that participants showed lower temporal discounting rates in the mortality salience condition than those in the control condition, who thought about dental pain. The essential elements of their experiment were as follows: Undergraduate students (mainly white women) from Texas A&M University were randomly assigned to either a mortality salience condition or to a control condition in which they thought about dental pain (intended to elicit thoughts of an aversive experience unrelated to mortality). In the mortality salience condition, participants were asked, "Please briefly describe the emotions that the thought of your own death arouse in you" and "Jot down, as specifically as you can, what you think will happen to you as you physically die and once you are physically dead." Thus, the experiment prompted a group of students who were, presumably (these factors were not reported), from relatively wealthy backgrounds and had relatively long life expectancies to consider their own mortality. It is likely that this manipulation simply increased their awareness of their existing internal estimates of their own life expectancies, without altering those estimates. Had the experiment used participants who expected their lives to be short and uncontrollable, contemplating their deaths might well have elicited increased temporal discounting. Further, had the experiment manipulated perceptions of the controllability of mortality risks, the results might have been different again.

In summary, the contextually appropriate response perspective predicts that people should become more present-oriented in response to indicators that future outcomes, including their longevity, are beyond their personal control. By contrast, TMT predicts that people should become more future-oriented after contemplating their own deaths and does not specify what the effects of perceived control over that death might be (Kelley & Schmeichel 2015; Liu & Aaker 2007). Further, the contextually appropriate response perspective offers an ultimate explanation (see Glossary – sect. 10): The unalterable prospect of a short life restricts the payback from investing in the future. In comparison, TMT offers a proximate account: Contemplating mortality induces an existential anxiety, which is buffered by efforts to leave a lasting legacy, engendering a focus on the future. In section 4, we state that ultimate explanations do not generally preclude proximate ones. However, this case provides an example of how a specific ultimate account can generate opposing predictions to one specific proximate one.

7. The implications of the contextually appropriate response perspective

How should the ideas we have presented so far change our approach to the question of socioeconomic differences in behaviour? A key implication of the contextually appropriate response perspective is that such concepts as locus of control and temporal discounting should be viewed not as fixed traits but as plastic responses that reflect one's environment and future prospects. Thus, rather than attempting to train people to be more future-oriented as an isolated cognitive intervention (as in Marko & Savickas 1998), it may be better to focus on addressing those factors that cause them to be present-oriented in the first place. For example, tackling sources of extrinsic mortality may not only reduce extrinsic mortality risk (a good thing in and of itself) but also alter BCD behaviours, increasing individual investments in longer-term outcomes, such as education. This conclusion echoes that of Geronimus (1996), who wrote on the matter of teen pregnancy:

> As a matter of social policy, focusing on teen pregnancy prevention as the solution to persistent poverty may be the modern-day equivalent to suggesting that those without bread can eat cake. Instead or in addition, policy approaches that would offer poor women and men real reasons to expect to live predictable, long lives deserve a prominent position on the policy agenda.

Although we believe that changes to the BCD would be best achieved by addressing the social-structural inequalities that we argue give rise to it, interventions that adjust perceptions might also be a fruitful avenue of investigation. As discussed previously, we have found that priming people to believe that prevailing mortality risks are controllable made them more likely to choose a healthy snack (Pepper & Nettle 2014a). An implication of this result is that, although we might expect the effects of deprivation to be somewhat entrenched, behaviour appears to remain plastic, at least to some extent. However, we do not know the extent to which improvements in a person's situation can compensate for past experiences and damage. More research is needed to determine the degree of malleability of behaviour over the life course. Conclusions from further

research could inform the development of interventions based around adjusting perceptions and could also answer important questions about the reversibility of the effects of early-life adversity.

The reversibility of the effects of early-life circumstances on health is an important area for future research. We have suggested that the effects of one's initial disadvantages can remain visible (relative to those of others who have not suffered those disadvantages), even after circumstances improve. However, we do not know to what extent the effects of initial disadvantage can be erased by bestowing later advantages. It is possible that there is a point of no return, after which the effects of early-life circumstances cannot be reversed. Alternatively, it may be possible to "catch up" in later life by overcompensating with behavioural and physiological investments in health.

Another important question concerns the accuracy of perceptions. Little is known about the extent to which people's perceptions reflect their objective situations. It is possible that perceptions of extrinsic mortality risk may become skewed as a result of media scare stories or exaggerated tales from peers (Sunstein 2003). If this is the case, simply working to correct those misperceptions may be sufficient to change behaviours in those whose perceptions are skewed. Conversely, people's perceptions may fairly accurately reflect their life chances (Lima-Costa et al. 2012; Mirowsky & Ross 2000). In this case, it might be considered unethical to adjust perceptions, and instead it would be better to focus on tackling sources of extrinsic mortality risk and improving people's future prospects. Furthermore, information gathered during early life may alter perceptions of, or responses to, environments in adulthood (Frankenhuis & Weerth 2013; Placek & Quinlan 2012; Sherman et al. 2015), in which case, understanding the interaction between early experience and current context will be extremely important.

Relatedly, the contextually appropriate response perspective suggests that public health campaigns designed to elicit healthier behaviour by highlighting risks may actually decrease health effort if those risks are perceived to be beyond individual control. As we discuss in section 6.1, increasing perceptions of the uncontrollability of overall personal mortality risk may decrease people's tendencies to invest in those areas of health that they *are* able to influence. This outcome could have important implications for the design of health and safety campaigns. For example, publicising the ways in which one can avoid becoming a victim of knife crime may make some people feel more equipped to avoid the danger. However, others may perceive themselves to have little personal control over their risk of being a knife-crime victim. For those people, such a campaign might unintentionally reduce the incentive to take other health-protecting measures (such as reducing alcohol intake) by making a subjectively uncontrollable risk more salient.

A further implication of the contextually appropriate response perspective is that we might expect control over mortality risk (and other future-limiting factors) to be a stronger predictor of BCD behaviours than SES itself. For this hypothesis to be tested, high-quality data on perceptions of control over mortality risk will be needed, and well-operationalised measures must be developed. We created a novel measure of perceived extrinsic mortality risk in a study that found that the association between self-reported SES and health effort was mediated by perceived extrinsic mortality risk (Pepper & Nettle 2014b). This measure needs to be validated, and its relationship to more objective measures should be explored.

Finally, we have argued that small initial disparities can lead to larger eventual inequalities (sect. 3.2). This observation helps shed some light on the puzzle of the persistence of health inequalities in modern welfare states (Mackenbach 2012). Even in the absence of abject poverty, an accumulation of smaller relative disadvantages may generate noticeable differences in such outcomes as healthy life expectancy through additive routes and feedback loops. An important question for future research will be to pinpoint the specific disadvantages that generate these differences, so that they can be addressed.

8. Clarifications and caveats

Several aspects of the contextually appropriate response perspective may require clarification. We have chosen to address these issues in their own section rather than disrupt the narrative of the preceding ones. Here, we present our clarifications in the order in which they have arisen in previous sections, linking back to them for ease of reading.

8.1. The BCD only applies on average

In section 2, we introduce the BCD, a cluster of behaviours that tend to be associated with economic deprivation. We wish to emphasise that the behaviours in the constellation only *tend* to be associated with economic deprivation, because poorer people, on average, experience more things that are beyond their control. However, some poorer individuals will not experience much that is beyond their control, and some higher-SES individuals might be present-oriented because of atypical experiences of low control. The contextually appropriate response perspective simply aims to explain why, *on average*, people of lower SES are less future-oriented than those of higher SES in a range of domains.

8.2. The BCD and concepts of risk

We have argued that temporal discounting is a common thread connecting the behaviours of the BCD (sect. 2.1), driven by the extent to which people view their futures as uncertain or as certain to be bleak. As such, our story may appear to be as much about risk as about temporal discounting. It is therefore important for us to make some clarifications regarding the concepts of risk and how they relate to our contextually appropriate response perspective.

When researchers refer to links between risk and temporal discounting, they may be referring to different things. Some studies examining associations between temporal discounting and "risky" behaviour use a loose conceptualisation of risky behaviour, encompassing most activities associated with an increased likelihood of experiencing undesirable outcomes, such as engaging in unprotected sex or using drugs recreationally (Laghi et al. 2012; Romer et al. 2010; Teuscher & Mitchell 2011). However, these real-world behaviours do not necessarily reflect the concept of risk acceptance as operationalised in many

laboratory-based studies. In psychological and behavioural economic studies, risk acceptance has been defined as a willingness to accept options offering a higher variance in payoff over those with equal expected values and a lower payoff variance (e.g., Daly & Wilson 2001). To give a simple example, a risky choice task might ask participants to choose between smaller guaranteed rewards (e.g., £5) and larger uncertain ones (e.g., a 50% chance of getting £10), which would pay out equal amounts if the choice were repeated over a longer term (the choices are of equal expected value). Our contextually appropriate response perspective helps us understand why lower-SES people might engage in real-world behaviours that might be classified as "risky" in the looser sense. However, it does not make predictions about SES differences in preferences for, or the acceptance of, risk defined as variability in outcomes.

To the extent that it will influence tolerance of the uncertainty inherent in any delay, people's level of risk acceptance may affect their temporal discounting. Studies have shown that when immediate rewards are made riskier (in the probabilistic sense) or future rewards are made less risky, preferences for immediate rewards are reduced, suggesting that temporal discounting is driven directly by preferences for certainty (Andreoni & Sprenger 2012; Weber & Chapman 2005). Thus, risk acceptance is one of many factors that may contribute to the BCD. Nevertheless, in this article, we have chosen to focus on the idea that, *all else being equal* (including risk acceptance in the sense of accepting variable outcomes), a lack of control over future outcomes leads people to prioritise the present.

8.3. The extrinsic-intrinsic distinction as a means of simplification

Inspired by models of the evolution of ageing, which make the distinction between extrinsic and intrinsic mortality risk, we have proposed that people adjust their behaviour in response to extrinsic mortality risk and other uncontrollable factors. However, it has been argued that no causes of mortality are *truly* extrinsic. Rather, in some cases, the effort required to counter mortality risk may be so great that, when traded off against other important endeavours, it is too costly to act to alleviate the risk (Kaplan et al. 2003). In section 2.2, we suggest that if you live in a neighbourhood beset by violent crime and cannot afford to move to a better neighbourhood, this risk is beyond your control. In this scenario, you might still take precautions to reduce your risk of becoming a victim of violence, but these may be too extreme to be realistically considered: For example, you might avoid leaving the house altogether to remain safe. However, this behaviour would generate substantial opportunity costs – for example, making it difficult to do paid work or to obtain food.

In the same manner, we have suggested that unhealthy behaviours do some amount of irreparable damage to health that, once done, could be considered extrinsic (sect. 3.2). This is a simplification, made for illustrative purposes. In truth, the damage is probably not irreparable: More likely, the payoff from allocating finite energy to somatic repair is less than the payoff from allocating it to other activities, meaning that the damage is not repaired (Cichoń 1997; Kirkwood 2002; Kirkwood & Austad 2000).

8.4. The BCD is not necessarily adaptive, and perceptions are not necessarily accurate

We have argued that BCD behaviours are comprehensible, given the circumstances commonly associated with economic deprivation, and have used concepts from the evolutionary literature to illustrate our point. However, we do not mean to argue that the BCD is necessarily evolutionarily adaptive (that it enhances Darwinian fitness). The tendency to prioritise more immediate outcomes over delayed ones may have been adaptive in ancestral environments that contained accurate cues to mortality, yet features of our contemporary existence may skew perceptions, and thus behaviour, away from what is strictly optimal (as defined in behavioural ecological models of the sort we present in sect. 3). For instance, as we mention in section 7, perceptions may be skewed by media scare stories or by films containing fictional violence – stimuli that would not have existed in ancestral environments. Thus, we do not suggest that the BCD is strictly adaptive, simply that BCD behaviours are a contextually appropriate response to the circumstances in which poorer people find themselves.

Relatedly, this raises the issue of the distinction between perceptions and reality. Throughout this article, we have assumed that perceived personal control and actual personal control are highly correlated. This is a tricky assumption, and few studies appear to assess the accuracy of people's perceived personal control over such factors as mortality risk. However, there have been studies on the accuracy of beliefs about the risk of death by certain causes and the extent to which people believe those risks can be ameliorated by societal actions (Girasek 2001; Hakes & Viscusi 2004; B. Smith et al. 1999). Such methods could potentially be adapted to determine the accuracy of people's perceived personal control over mortality risk.

8.5. More experimental evidence is needed

Although we have reviewed a great deal of evidence in support of the contextually appropriate response perspective (sect. 5), much of this evidence is correlational. As such, it cannot confirm causal links between expectations of the future and BCD behaviours. Generally, these studies are correlational because of the logistical and ethical challenges involved in manipulating people's future prospects to study the results. This is problematic, because it is important to address the potential for confounds and the possibility of reverse causation. One way of beginning to do this is to manipulate people's perceptions of future-limiting factors, such as extrinsic mortality risk, before measuring their short-term behavioural responses. This has been done in a number of experiments, some of which have been reviewed above and which we emphasise in this section.

A number of the TMT studies examining the effects of mortality salience have generated results that fit with the contextually appropriate response perspective. For example, experiments based on TMT have found that making mortality salient leads people to report wanting to have children sooner (Fritsche et al. 2007; Wisman & Goldenberg 2005). However, the TMT explanations for these

findings are rather different from those we have outlined, as discussed in section 6.2.

Some priming studies manipulating perceived mortality risk reported subsequently increased delay discounting and desires to have children sooner, but only among lower-SES participants (Griskevicius et al. 2011a; 2011b). Similarly, one study showed that male participants reported wanting more children after answering questions designed to make them think about mortality (Mathews & Sear 2008).

Some of our own experiments, mentioned in section 4.1, have found that if people were primed to feel that prevailing mortality risks were controllable, they were subsequently more likely to choose a healthy snack than an unhealthy one (Pepper & Nettle 2014a). These experiments were subtly different from those mortality priming studies mentioned above, because they were specifically designed to systematically manipulate the perceived controllability of mortality risk rather than simply to make mortality more salient.

Another interesting result comes from an experiment that may have manipulated perceived controllability of mortality risk without directly intending to do so. Callan et al. (2009) investigated the impact of "just-world threat" on temporal discounting. They exposed participants to a video of a woman talking about her experience of living with HIV. Half of the participants were subsequently told that the woman had contracted HIV by having unprotected sex with someone she met at a friend of a friend's party. The other participants were told that she contracted HIV after being in a car accident and getting infected by a contaminated blood transfusion. The authors designed the latter scenario to be a just-world threat in which the woman could be perceived as an innocent victim who had contracted HIV without having done anything to deserve it. Participants who were exposed to this just-world threat subsequently discounted future rewards more steeply than those who were told that the woman contracted HIV after unprotected sex. Callan et al. interpreted this finding as a link between the need to believe in a just world and the ability to delay gratification. An alternative interpretation of this finding is that the just-world threat scenario acted as a cue to extrinsic mortality risk, thereby provoking the prioritisation of more immediate rewards.

One behavioural economic experiment used a paradigm designed to separate the effects of poverty per se from those of income shocks (Haushofer et al. 2013). Study subjects were either given large initial endowments (the "always-rich" group) or small initial endowments (the "always-poor" group). All participants then performed 15 rounds of work on a task that earned them money and were presented with information about their current wealth relative to that of other participants at the end of each round. Some of the participants in the always-rich and always-poor groups then experienced sudden and unexpected changes (increases or decreases) in their wealth levels. Subsequently, measures of temporal discounting were taken. Always-rich and always-poor participants who had not experienced unexpected wealth changes did not discount future rewards differently. However, participants who had experienced negative income shocks (unexpected decreases in wealth) subsequently discounted future rewards more steeply, regardless of whether they were in the always-rich or always-poor group. The unpredictable and uncontrollable nature of the income shocks had an effect that was not generated by simply being relatively poor within the context of the economic game.

One finding regarding the importance of control comes from an experimental intervention designed to improve outcomes for those living with poverty and social exclusion. Ghosal et al. (2013) reported a randomised controlled trial of an intervention designed to bolster a sense of agency among sex workers in Kolkata. The intervention resulted in participants' making increased efforts to save money for the future (they were more likely to invest their programme participation payments into bonds that would take a year to mature) and to take care of their health (they made more visits to their doctors).

The results of these experiments lend support to the contextually appropriate response perspective, but the majority of them were not designed to directly test it. Further experimental tests are needed, and methods can be built upon these initial experimental attempts at manipulating factors such as perceived mortality risk.

9. Conclusion

We have introduced a behavioural phenomenon associated with SES, which we call the *behavioural constellation of deprivation* (BCD; see sect. 2). We have established that the behaviours of the constellation are characterised by disinvestment in the future, which we view as a contextually appropriate response to having a limited ability to ensure returns on investments in future outcomes (sects. 2.1–2.4). We have also discussed the evolutionary theoretical models that inspired this contextually appropriate response perspective (sect. 3). We have outlined how key principles from these models can help us understand the dynamics of the BCD: (1) Small initial disparities can lead to larger eventual inequalities, (2) feedback loops can embed early-life circumstances, (3) constraints can breed further constraints, and (4) feedback loops can operate over generations. We have discussed the mechanisms by which restricted control over future-limiting factors might generate BCD behaviours, making the distinction between proximate and ultimate types of explanation (sect. 4). We have reviewed literature from other fields, which has converged on similar conclusions regarding the roles of perceived control and the future in explaining behaviours from the BCD (sect. 5). Then, we have offered some specific examples of how the contextually appropriate response perspective differs from other approaches (sect. 6). Finally, we have highlighted some of the key implications of the contextually appropriate response perspective for policy and future research (sect. 7) and outlined some important clarifications and caveats (sect. 8).

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10. Glossary

Socioeconomic status (SES) refers to ranking in a social and economic hierarchy and is usually measured by one

or more factors, including education, occupation, income, and personal wealth.

The **behavioural constellation of deprivation (BCD)** is the cluster of behaviours associated with socioeconomic status, described in this article (sect. 2).

The **contextually appropriate response perspective** proposes that behaviours can be understood as appropriate responses to the challenges faced by an organism within a given context.

Extrinsic mortality risk is the part of a person's risk of death that *cannot* be influenced by their investment in healthy behaviour or physiological repair. It is the portion of total mortality risk that is not intrinsic.

Intrinsic mortality risk is the part of a person's risk of death that *can* be influenced by their investment in healthy behaviour or physiological repair. It is the portion of total mortality risk that is not extrinsic.

Impulsivity has been described in various ways. For example, impulsivity has been defined as a tendency to act with less forethought than others with equal ability and knowledge. It has also been defined as the propensity to have rapid, unplanned reactions to stimuli without considering the negative consequences of these reactions.

Generativity refers to the belief that one's actions have future consequences.

Time preference describes how an individual's preference for an outcome varies as a function of the time to reach that outcome.

Time perspective describes the extent to which a person's focus on past, present, and future experiences influences their decision making in the present.

Future discounting is the tendency to choose smaller-sooner rewards over later-larger ones. Future discounting is also referred to as **temporal discounting** or **delay discounting** and is often used as a **measure of time preference**. The inverse of future discounting is often referred to as the **ability to delay gratification**.

Future orientation describes the extent to which a person focusses on future outcomes, with **present orientation** being the converse.

Consideration of future consequences describes the extent to which a person's consideration of future outcomes influences their behaviour in the present.

Locus of control describes the extent to which a person believes that their life outcomes are determined by their actions rather than by the actions of others or by chance. At its simplest, a person's locus of control can be described as internal (a result of their own actions) or external (resulting from external forces, including the actions of others).

Health locus of control is the same as the concept of locus of control (above) but is applied specifically to health outcomes. Note that the **Multidimensional Health Locus of Control Scale (MHLC)**, a commonly used measure of health locus of control, does not measure perceived control over *mortality* risk but focusses on control over *morbidity* risk.

Self-efficacy describes the extent to which a person believes in their own ability to complete a task. This is also referred to as **perceived behavioural control**.

Ontogeny is the developmental life-span of an organism.

Ontogenetic calibration is the process of an individual adapting to its environment during the course of development.

Ultimate explanations address the question of *why* something should be. They usually involve identifying the evolutionary (adaptive) function of a trait or behaviour.

Proximate explanations address the question of *how* something happens. They usually involve identifying physiological or psychological mechanisms that produce a trait or behaviour.

The uncontrollable mortality risk hypothesis is the hypothesis that people who perceive that they are likely to be killed by factors beyond their control should be less motivated to invest effort in looking after their future health, because they are less likely to survive to reap the rewards of their healthy behaviour.

Open Peer Commentary

Public health interventions can increase objective and perceived control by supporting people to enact the choices they want to make

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Abstract: "Low-agency" public health interventions do not rely on individuals using their personal resources to benefit. These help people enact the choices they wish to make and are likely to increase objective and perceived control. Lower-agency interventions have been criticised as constraining individual choice. Pepper & Nettle show that this is unlikely to be the case.

As a public health researcher, I am primarily interested in the "so what?" of behavioural science. I want to know what solutions are available to solve the problems we so often identify in research. Thus, I found myself reading Pepper & Nettle's (P&N's) eloquent and convincingly argued target article, wondering what the dénouement would be in terms of implications for interventions.

The authors identify that reducing extrinsic sources of mortality to increase perceived control is likely to be "best achieved by addressing the social-structural inequalities" (sect. 7, para. 2). However, they do not linger long on this option, presumably considering wholesale social and political change to be beyond the reach of most behavioural scientists. Otherwise, they are concise and somewhat circumspect. One of their few concrete suggestions is to manipulate perceived control, but they acknowledge that it may be unethical to manipulate perceptions beyond the objective "truth." If wholesale social and political change is off the table, then perhaps we must accept that persistent socioeconomic differences in objective control will persist. This circumstance leaves the potential for manipulating perceived control within the bounds of the "truth" somewhat limited.

However, maybe there is a middle ground. Perhaps it is possible to manipulate objective – and, hence, perceived – control without resorting to wholesale social and political change. Reflecting P&N's proposals, in the field of dietary public health, growing evidence suggests that many parents find it hard to enact their desire to feed their families and themselves better for reasons beyond their control. For example, mothers living in low-

income neighbourhoods describe wanting to provide more fruits and vegetables for their children but not having the money to afford them or the time to prepare them (Jabs et al. 2007). Qualitative interviews and preliminary outcome evaluations reveal that programmes that subsidise fruit and vegetable purchases can literally help mothers put fruit on the table (Bowling et al. 2016; Cohen et al. 2017; Lloyd 2014; McFadden et al. 2014). These findings suggest that increasing the financial availability of healthier foods increases parents' ability to enact the choices they want to make. In other words, and perhaps as P&N would rather put it, these interventions increase objective *and* perceived control.

Other interventions might also be expected to increase control over diets. These include changing the cognitive availability of healthier versus less-healthy food via restrictions on food marketing (Galbraith-Emami & Lobstein 2013) and changing food's physical availability via planning restrictions on hot-food takeaways (National Institute for Health and Care Excellence 2013). Parents have identified ubiquitous exposure to advertising for less-healthy foods and hot-food takeaways as undermining their intentions to ensure their children eat well (Burges Watson et al. 2013; Khanom et al. 2015).

Adams et al. (2016) have previously argued that what unites these interventions that support people to enact the choices they want to make is that they are "low agency"– that is, they do not rely on potential recipients' using their personal resources, or "agency," to benefit. Instead, they act by changing the physical, financial, and cognitive availability of healthier choices.

In contrast, higher-agency interventions are generally focused on providing information via a variety of sources, including individual or group-based counselling, the mass media, social marketing campaigns, and labelling. Such information-based interventions rely on recipients' not just reading or listening to and remembering information but also being able to act on the changes that the information advocates. In environments where only some choices are physically, financially, or cognitively available, implementing this information can be nearly impossible. It is not difficult to see why these circumstances might undermine individuals' perceptions of the control they have over their diets. Indeed, it is difficult not to conclude that individuals in these circumstances truly have little control over their diets.

It is clear that in many contexts, fruits and vegetables are more expensive than other foods that are less healthy (Jones et al. 2014; Monsivais et al. 2012). When this is the case, only those with financial resources to spare (i.e., the less deprived) are able to implement advice to eat more fruits and vegetables. Similarly, when any aspect of the financial, physical, or cognitive environment makes information-based interventions harder for those living in more-deprived circumstances to implement, such interventions are likely to exacerbate existing socioeconomic inequalities in behaviour (Adams et al. 2016). This situation reflects P&N's proposal that "public health campaigns designed to elicit healthier behaviour by highlighting risks may actually decrease health effort if those risks are perceived to be beyond individual control" (sect. 7, para. 5). White et al. (2009) have described these inequities in response to higher-agency interventions as "intervention-generated inequalities" (p. 68).

One of the common concerns with lower-agency public health interventions is that they impinge on individual choice (Frieden 2010; Nuffield Council on Bioethics 2007). Such interventions as soda taxes, regulation of food advertising, improvements to the nutritional quality of food served by takeaways, and changes in the density of such takeaways have all received the "nanny state" criticism from various quarters (Anon 2014; Henderson et al. 2009; Jou et al. 2014; Littlejohn 2008). And this criticism is not just journalistic rhetoric – the concerns about constraining choice and control that are wrapped up in the "nanny-state" label can decisively influence whether interventions are implemented (Giles et al. 2016). Importantly, P&N's thesis makes clear that by increasing recipients' control over their health behaviours, lower-agency interventions are likely to increase choice rather than decrease it.

From an applied public health point of view, the conclusion that lower-agency interventions can increase choice and control is perhaps the most important implication of P&N's article. The common, but flawed, argument that lower-agency public health interventions constrain choice and control needs to be clearly and consistently challenged.

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The behavioral constellation of deprivation may be best understood as risk management

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Abstract: Although the authors make a compelling case that early-life deprivation leads to present orientation, we believe that such behaviors may be better understood in terms of an underlying risk-management strategy, in which those who experience such deprivation are more risk-averse. The model we sketch accommodates the authors' present-orientation observations and further explains differences in risk preferences and social preferences.

Pepper and Nettle (P&N) make a compelling case for the existence of a constellation of behaviors that result from early-life deprivation. This behavioral constellation of deprivation (BCD) is described in terms of intertemporal choice: To decide between mutually exclusive immediate and delayed rewards, one must discount future rewards to the present and then compare like with like. P&N argue that what ties early-life deprivation to the BCD is a contextually appropriate increase in individuals' discount rate: Those who grow up in deprived environments value a future dollar less than those who grow up in enriched environments. Changes in discount rates account for the data presented, but changes in *risk* preferences – as opposed to pure time preferences—may also account for the BCD. An unwillingness to delay rewards might reflect a range of uncertainties – uncertainty that the future reward will be obtained, that the individual will be there to obtain it, that the reward will retain the same value in the future, and so on.

Managing these uncertainties is a fundamentally different problem for those living or raised in abundance and those living or raised in deprivation. For example, small and moderate fluctuations in resources (income, calories, etc.) are unavoidable, but only those at the margins feel the full effects of such fluctuations and, consequently, must be more attentive to variability in their environment and the downside risk of their decisions. Our risk-management view of the BCD allows us to generalize P&N's model such that it makes predictions about the effects of early-life deprivation in any domain in which effects of uncertainty depend on differences in socioeconomic status (SES). Thus, in addition to accounting for the BCD in terms of risk management rather than temporal discounting, we would like to discuss how this risk-management view applies to two domains outside

intertemporal choice: laboratory-based assessments of risk preferences and the role of social preferences in managing risk.

How does early-life deprivation affect risk preferences in later life? We are careful here to distinguish between what the authors call risky behavior (activities, such as unprotected sex, associated with undesirable outcomes) and risk acceptance (lab measures that capture willingness to accept an increase in outcome-variance in exchange for an increase in expected value); we only discuss the latter here. P&N say their model does not make predictions about such risk preferences, but a risk-management model does, and in a recent set of studies (Jordan et al. 2017), we sought to investigate this exact question. We elicited risk preferences in two ways. The first was a series of questions that asked whether the participant preferred smaller, guaranteed rewards over larger, but uncertain rewards. The second was an incentivized measure of risk, the Balloon Analog Risk Task, in which participants inflated a digital balloon and could win money with each successive pump. However, participants could only keep the money if they cashed out before the balloon popped (which increased in likelihood with each pump). Across both tasks, we found a robust relationship between childhood SES and risk acceptance, such that low childhood SES was associated with *risk aversion* over and above current SES. These results provide some evidence that risk preferences are indeed affected by early-life environments. Additionally, these results highlight the relevance of thinking about early-life deprivation in terms of risk management, in part because they add a decision problem to the BCD that is not an intertemporal choice, but also because there is no way to translate these risk assessments into a present-future trade-off.

In addition to affecting risk preferences, differences in risk-management strategies should lead to differences in social preferences. One of the most important ways in which individuals from low SES backgrounds can buffer against uncertainty is to pool the risk of income fluctuations by building reciprocity relationships – if I help you when you are in need, then you may be more likely to help me when I am in need. Therefore, the risk-management perspective predicts that those who experience early-life deprivation should be *more* cooperative, because developing reciprocity relationships reduces downside risk. What does the P&N model predict about these behaviors? Conveniently, models of repeated interaction contain a parameter (delta) that has a straightforward interpretation in terms of intertemporal choice: If a decision maker in a repeated game values the future sufficiently highly (high delta, low discount rate), he or she will cooperate, because long-term cooperation is worth more, in virtue of the low discount rate, than defection. Here, the two models appear to make competing predictions: The risk-management model predicts more cooperation among those raised in deprivation, because it manages risk, while the P&N model predicts less cooperation, because the BCD is marked by a high discount rate (low delta). To test these predictions, we can look to a growing body of work that suggests that those who are currently of lower SES are more prosocial (Piff et al. 2010), and that this relationship is mediated by factors P&N point to as relevant to the BCD, such as locus of control (Kraus et al. 2009). Critically, however, we have found that early-life deprivation is associated with greater prosociality and explains more variance in prosocial decision-making than current SES (Jordan et al. 2017). Thus, to the extent that early-life deprivation leads to greater prosociality, it appears that risk management more fully accounts for the data than temporal discounting.

In sum, we believe the risk-management view of early-life deprivation may be a more powerful framework with which to understand the BCD. Given that intertemporal choice can be rephrased in terms of risk aversion (greater present orientation is akin to greater risk aversion), and that childhood SES is a robust predictor of risk preferences and social preferences, we believe that the BCD is best understood as a function of risk-management strategies rather than as an intertemporal choice per se.

Developing the behavioural constellation of deprivation: Relationships, emotions, and not quite being in the present

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Abstract: Although it is a welcome and timely idea, the behavioural constellation of deprivation (BCD) needs to explain how the development of personal control, trust, and perception of future risk is mediated through relationships with parents. Further, prioritising the present over the future may not be the essence of this constellation; perhaps *not* quite being, either in the present *or* in the future, is a better depiction.

This paper may signal the beginning of the end of psychology's failure to embrace political realities and tackle injustices. Its breadth of perspective is refreshing and very welcome. However, it raises several puzzling questions, two of which we hope to address in this commentary.

First: *How* is the behavioural constellation of deprivation (BCD) actually picked up by children? If Pepper & Nettle's (P&N's) argument is to hold, children must experience or grasp something like an extrinsic mortality risk – or perhaps some other risk to resources in the future – and thus act to prioritise the present over the uncertain future. However, how does the child *perceive* these threats? The authors quite rightly mention the role of learning through peer-group interactions – what might be called a horizontal transmission of culture – as well as the epigenetic consequences of early experiences. The authors primarily mention intergenerational – or what might be called vertical – transmission in the context of health factors. But relationships with parents are crucial to the development of personal control, trust, and perception of future risk; and understanding these relationships must be at the heart of the developing BCD.

From the earliest months, children and their caregivers continuously influence and change each other's states of being (Beebe et al. 1992). Self-regulation – which is the inevitable terrain in issues surrounding a future orientation – emerges within the dynamics of these relationships (Dix 1991), with parents' own impulsivity and emotion regulation constituting a crucial impact on children's self-regulation (Bridgett et al. 2015). In clinical groups, mothers with borderline personality disorder, in which impulsiveness is the core symptom, are more intrusive and insensitive toward their infants; their infants are less organised and positive in their emotional states and more often categorised as having "disorganized" patterns of attachment (Hobson et al. 2005). In nonclinical populations, caregivers' self-regulation appears to determine the extent to which they control their own reactions to children's challenging behaviours, which in turn reciprocally influence the children's self-regulation. A similarity between parents and children seems evident from many studies in levels of self-control and impulsivity (Boutwell & Beaver 2010) and in executive functioning capacity (even after controlling for parental education and verbal ability; Cuevas et al. 2014). Clear links

between harsher parenting styles and higher levels of children's problem behaviours seem apparent, but only among mothers with poorer executive function (i.e., in the regulation of attention, inhibitory control, and working memory; Deater-Deckard et al. 2012). Caregivers' self-regulation appears to influence children in a broader way, creating the developmental niche to which the children need to adapt. For instance, chaotic and disorganised households appear negatively related to parental responsiveness to and acceptance of their children, which in turn predicts lower levels of executive functioning and self-regulation in kindergartners (Vernon-Feagans et al. 2016). Given the fairly exhaustive evidence about the importance of intergenerational influences in the BCD, particularly with regard to impulsiveness, neglecting these processes not only leaves an undesirable gap in the explanation but also seems to imply that the children's experience of (and adaptation to) the world of deprivation is minimally mediated by relationship.

There is a second puzzle concerning the "the prioritisation of the present over the future." The authors' perception of this prioritisation as an adaptive and contextually appropriate rather than pathological or maladaptive response is refreshing and intriguing, but – and this is its intriguing challenge – it raises two apparent contradictions. A focus on the present, on living in the now, on being in the moment is a well-known injunction from meditative (particularly Buddhist) traditions (Goldstein 2013) and has been taken up by the vast "mindfulness" industry as being important for well-being. Further, a focus on the present/the now/the moment is also a necessary condition of what might be called genuine engagement, whether with people or with the material world (Buber 1958; Reddy 2008; Stern 2004). In fact, P&N too could be taken to imply that this ability to resist the plans and lure of the future and experience the present as fully as possible allows genuine conversation, better communication, and a more sensitive way of knowing the world.

How does the dichotomy of present-versus-future orientation fit with the other literature? Our suspicion is that P&N's use of the term requires an additional emotional dimension – anxiety, desire, or dissatisfaction – that, rather than constituting a prioritisation of the present, does not really *allow* a focus on or orientation toward the present. The behaviours implied in the BCD seem to reflect an attentional orientation to the nearest future, with almost an absent-minded attitude toward the present. It is possible that the contradictions are more apparent than real. In the meditative and mindfulness tradition, being in the present involves an explicit and reflective focus on a narrow connection – for example, with a flower, a thought, or a person's smile. In contrast to the unreflective distractedness and impulsivity implied in the BCD, being in the present not only is reflective, but also involves effortful handling of distraction and irrelevance. P&N's focus on "balancing of costs and benefits in the present with those likely to be realised in the future" is almost anathema to the kind of focus on the present moment in the meditative literature – even simply being *aware* of costs and benefits is precisely *not* being in the present. P&N talk of *assessing* the worth of events and objects in the present, but the other tradition deals with *experiencing* the present. In the "engagement" and communication literature, similarly, being in the present involves an openness to and interest in another person, object, or experience without the impulsivity or the impatience implied in BCD. Engaging in the present requires a harmony of desire and interest with that which is available in the present. In contrast, the BCD seems to reflect a disharmony in the present-orientation implied in P&N's use of the term – a dissatisfaction with being in general, which allows neither an awareness of the present nor a trust in the distant future. In both of these traditions (mindfulness and engagement), the emotional dimension is crucial to explain what is meant by being in the present, and this dimension needs to be added to P&N's theory to qualify their use of the term "present-orientation," perhaps shifting it to a not-quite-present and not-quite-future orientation.

The elusive constellations of poverty

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Abstract: Pepper & Nettle describe possible processes underlying what they call a behavioral constellation of deprivation (BCD). Although we are certain about the application of evolutionary models to our understanding of poverty, we are less certain about the utility of behavioral constellations. The empirical record on poverty-related behaviors is much more divergent and broad than such constellations suggest.

Poverty is a wicked problem that has consistently defied attempts at reduction to simple causes or processes. In recent years, much effort has been put into analyzing diverse findings on poverty (and the related issues of deprivation and differences in socioeconomic status [SES]) and in developing theoretical perspectives to integrate these findings. The article by Pepper & Nettle (P&N) contributes to this effort by drawing together various research lines on SES differences and temporal discounting, describing what they call a "behavioral constellation of deprivation" (BCD). P&N present an interesting perspective on deprivation, especially in the application of evolutionary models on the effects of mortality risk to SES differences, yet we have doubts about the integrative value of the "behavioral constellations." Like the observation that constellations in the night's sky are not used in contemporary astronomy because they exist more in the eye of the beholder than in systematic relationships between celestial bodies, we argue that P&N's B*CD (1) overestimates the coherence of the various behaviors associated with poverty and (2) underrepresents the range of behaviors that should be included in such a constellation.

First, as far as coherence in characteristics of poverty is concerned, the empirical record has proven to be rather stubborn. Various reviews have come to the conclusion that results are not consistent across methodologies (Duncan et al. 2017), that there is no conclusive support for any single explanation (Pampel et al. 2010) and that there is no common solution to problems of poverty (Banerjee & Duflo 2011). Such empirical variation makes it hard to talk about a behavioral constellation or about exclusive psychological or environmental factors underlying such a constellation.

Studies on behavioral and psychological characteristics of low SES and poor samples rarely include the full range of measures representing a constellation. Rather, evidence for constellations mainly comes from narrative reviews like the one by P&N, drawing together findings from separate studies without clearly explaining criteria for their inclusion or exclusion. A risk of this strategy is selectively including only those studies that provide convergent evidence. There are, however, many divergent results. For example, correlational studies and (quasi-)experimental studies on the consequences of poverty have frequently yielded

markedly different results (Duncan et al. 2017). In addition, the direction and magnitude of effects have been found to vary across behavioral phenomena associated with poverty. For example, poor people have been found to sometimes make worse decisions, because poverty "impedes cognitive function" (Mani et al. 2013), but at other times make better decisions, because "scarcity frames value" (Shah et al. 2015). Other studies, linking poverty with decision making, do not show any consistent effects at all. For example, Carvalho et al. (2016) do not find any differences between before and after payday in relation to risk taking, quality of decision making, and cognitive function tasks. Sometimes, a lack of systematic differences can be explained by complex relationships underlying observations. For example, Callan et al. (2016) have found that personal relative deprivation and subjective SES class acted as mutual suppressors, obscuring the relationship between SES status and prosocial behaviors. These examples illustrate the variability and complexity of the empirical record on the effects of poverty on behavior when looking for constellations of behavior.

Second, poverty, SES, and deprivation are such broad constructs that one would expect them to relate to a broad set of behaviors. Indeed, the literature on these constructs is diverse, ranging from health-related behaviors, to emotional experiences, to social and moral behaviors. Likewise, the range of associated environmental factors and psychological processes explaining such behaviors is much broader than those proposed by P&N. It includes, for example, reduced cognitive bandwidth (Mullainathan & Shafir 2013); stress and negative affect (Haushofer & Fehr 2014); experienced societal rank and increased contextualism (Kraus et al. 2012); childhood economic conditions, impulsivity, and risk (Griskevicius et al. 2013); culture and inheritance of dysfunctional beliefs, values, and behaviors (Lewis 1966); shame and stigma (Walker 2014); and generalized trust (Hamamura 2012). P&N choose to be rather restrictive in their inclusion of processes and behaviors, focusing on extrinsic mortality risk, lower environmental control, and increased temporal discounting. Because these factors have also been included in previous overviews of the link between poverty and decision making, such as by Mullainathan and Shafir (2013) and Haushofer and Fehr (2014), the question is what such a restrictive constellation adds to our understanding of poverty. One possibility may be the application of models from evolutionary biology, answering the questions of why behavioral constellations should be observed in the first place and how they can be seen as contextually appropriate responses. However, the question remains: Why do P&N not apply this reasoning to a wider range of behaviors? Perhaps the most explicit omission is that of risk, which is assumed to be directly related to wealth in classical economic models and has been explicitly related to poverty by Griskevicius et al., who argue that people who grew up in poverty are not only less likely to defer immediate rewards but also should be more risk seeking in times of stress and when exposed to mortality cues. Although the evidence on risk is mixed (Carvalho et al. 2016), a behavioral constellation including a broader range of behaviors would clearly be of more heuristic value to researchers and practitioners dealing with poverty.

To conclude, we think that P&N contribute an interesting perspective on poverty and associated behavior that merits further study. However, at the same time, we believe that the diversity of the empirical record and the narrow focus of their paper clearly limits their claim for the existence of a BCD. In line with more situational analyses (Banerjee & Duflo 2011; Bertrand et al. 2004), we believe that problems of deprivation and poverty for the moment benefit more from specific, tailor-made analyses and solutions than from broad constellations that might exist more in the eye of the beholder than in the empirical record.

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Interpreting risky behavior as a contextually appropriate response: Significance and policy implications beyond socioeconomic status

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Abstract: The significance of the contextually appropriate response perspective (CARP) can be judged, in part, by its potential to stimulate new research and guide public policy. To illustrate this potential, I move beyond socioeconomic status differences in behavior and apply CARP to broader, policy-relevant issues in criminology. In this area, CARP sheds new light on some old problems.

Theoretical perspectives can be judged by a number of standards, but two important dimensions include (1) the potential of a perspective to stimulate new lines of research and (2) its utility in the policy arena. Focusing on these criteria, I find the contextually appropriate response perspective (CARP) to be highly significant. Further, I believe CARP can shed new light on issues that stretch well beyond socioeconomic status differences in future discounting and risky behavior. To illustrate, I discuss some unexpected findings in criminology and show how CARP can make sense of these findings and advance related research.

Of special interest is CARP's ability to explain the failure of interventions based on fear and deterrence. Specifically, as Pepper & Nettle observe, health promotion efforts that highlight the risks of unhealthy behavior can have unintended consequences and may *decrease* healthy behavior. In particular, such efforts may increase pessimism about the future and lead to future discounting – especially when the health risks are seen as uncontrollable. This observation is extremely relevant to fear-based interventions in criminal justice.

In the United States, "Scared Straight" programs remain popular and are the focus of a highly rated television series. In such programs, juvenile offenders visit a prison and hear a presentation by inmates about the horrors of prison life. They are told they will end up in prison if they continue their behavior and that there is a good chance they will be raped and assaulted once in prison. Despite the popularity of such programs, evaluation research indicates they *lead to more offending* (Petrosino et al. 2013). The reasons for this outcome remain a mystery and came as a surprise to researchers. One possible explanation is that participating juveniles felt a need to engage in future delinquent acts to show they are not scared by the program. Another intriguing possibility is that, by highlighting the prison horrors that await them, these programs increase pessimism about the future and thereby elicit a contextually appropriate response (i.e., future discounting and more present-oriented, risky behaviors).

Regardless of whether they have formally participated in a Scared Straight program, young offenders report that they often receive similar fear-based messages from teachers and family members (Hoffman 2004). As with Scared Straight programs, there is reason to believe these messages *produce the very response they are designed to deter*. To use an example from my own research, the following young offender describes how such messages increased his pessimism about the future and, in turn, his motivation to offend: "The way I was going, I didn't think I was ever going to see [age] 19. I swear. My aunties used to always say, 'Man you gonna be dead..' . . Made me wanna go do some more bad stuff" (Brezina et al. 2009, 1114).

In short, CARP may help explain the failure of deterrence, including unexpected "backfire" effects. The threat of punishment may increase future discounting and lead to more risky behavior, and this may be especially true for individuals who are pessimistic

about their futures to begin with. Fear-based approaches may remind individuals of their current low statuses, reinforce negative future expectations, and thereby trigger contextually appropriate responses. According to "commonsense" notions about punishment and deterrence, the threat of future punishment should serve as a powerful deterrent – but this belief assumes that the target of the threat has a desirable future to jeopardize.

In terms of actual punishment, it appears that some individuals are more responsive than others to punishment experiences, and this issue is now receiving a good deal of attention from criminologists. Punishment appears to deter some offenders, while others respond with defiance and more offending. The reasons for "differential deterrence" are not entirely clear, but variables highlighted by CARP may prove to be key. Differential deterrence may be a product, in part, of individual variations in perceived control over the future. Qualitative studies indicate that many serious offenders assume they are "doomed to deviance" – an assumption that punishment experiences may reinforce. Perhaps punishment is more effective as a deterrent when individuals believe they have the power to select an alternative future (see Maruna 2001).

Positive expectations for the future have been described as an important type of "motivational capital" or cognitive resource that individuals can draw on in the decision-making process. In effect, positive expectations can incentivize behavior that is "designed to achieve that 'future me'" (Clinkinbeard & Zohra 2012, 238). Further, interventions that focus on positive future outcomes have shown some success. For instance, a seven-week "school-to-jobs" intervention that targeted disadvantaged students used structured class sessions to promote the development of positive future expectations (especially future "academic" selves) and to help youth identify strategies for realizing these expectations. An experimental evaluation revealed that, relative to a control group of nonparticipants, the intervention was associated with increased school attendance, time spent on homework, class participation, and a reduced risk of classroom misbehavior and depression (Oyserman et al. 2006).

In summary, CARP is likely to stimulate new policy-relevant research in criminology. If future research confirms my suspicions, CARP will help us better understand why programs often produce unintended effects – an understanding that could lead to more effective and humane interventions (e.g., programs that combine punishment/incarceration with services that better prepare ex-offenders for the future). In this sense, CARP may help us exercise greater control over the future. The timing appears to be right in the United States, as there is growing recognition among policy makers of the limits of harsh and costly punitive measures, such as mass incarceration and strict "zero-tolerance" policies in schools – measures that reduce the life chances of those affected and often backfire.

Epigenetic-based hormesis and age-dependent altruism: Additions to the behavioural constellation of deprivation

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Abstract: We support Pepper and Nettle's (P&N's) hypothesised adaptive responses to deprivation. However, we argue that adaptive responses to stress shift with age. Specifically, present-oriented behaviours are adaptive for young people (e.g., in terms of mating and reproduction) but costly for older people in deprived communities who would benefit from investing in grandchildren. Epigenetic mechanisms may be responsible for age-related tactical shifts.

Pepper & Nettle (P&N) have delivered an important contribution to the field by hypothesising that people exhibit behaviourally adaptive responses to deprivation. Further, we are pleased that the authors acknowledge that DNA methylation may play a role in the behavioural constellation of deprivation (BCD). Caution is needed, as most human behavioural epigenetics research (among healthy individuals) is correlational or blood- or saliva-based and therefore does not permit an understanding of the underlying functional molecular physiology. Inflammation is only one logical possibility, as suggested by P&N, but epigenetic profiles involved in the BCD likely vary by age and tissue type. For example, DNA methylation, a well-studied epigenetic alteration, varies by age, sex, tissue, cell type, and isoform, making blood-based correlational studies potentially misleading. Work by Horvath (2013) on the epigenetic clock indicates that, regardless of tissue type, chronical age can be predicted with high accuracy from DNA methylation profiles. In the case of pathological tissue (e.g., cancerous tumours), epigenetic age is advanced relative to healthy tissue (Horvath 2013; 2015). We argue that the precision of the epigenetic clock indicates specific life-history adaptations that are system-wide. In the case of impoverished environments, we suspect from an evolutionary and epigenetic perspective that adaptive responses to stress by young people (e.g., present-oriented behaviours) should be qualitatively distinct from the adaptive responses to stress by older people (e.g., future-oriented behaviours, such as altruism and giving social support). Indeed, we hypothesise that if older people were to maintain a BCD strategy suggested by P&N, they would be at an inclusive fitness disadvantage compared to those who employ a life-history-dependent shift (e.g., caring for grandchildren, community-based altruism). From an epigenetic-profiling perspective, we expect a shift in profiles as we age to correlate with changes in the behavioural adaptive responses to deprivation. For example, the behavioural strategy that works best for a 21-year-old facing deprivation would be costly for a 60-year-old. There is an important analogy to be made between the emphasis on mating for younger people and the shift toward parenting among older people. Brown (2015) suggests that genes important for growth (e.g., development of secondary sexual characteristics, such as big muscles in young men) could become costly later in life (e.g., development of cancers). Such effects are consistent with antagonistic pleiotropy perspectives on senescence, the proposal by Williams (1957) that a gene controlling one trait could be beneficial to the organism's fitness at younger ages and detrimental to the organism's fitness later in life. We believe it is important for P&N to extend the BCD model to incorporate epigenetic adaptive responses to antagonistic pleiotropy, which may be more marked in deprived environments.

A second related issue raised by P&N is the importance of studying pathological responses to deprivation. Specifically, they propose in the target article abstract that they "emphasise the idea that the present-oriented behaviours of the constellation are a contextually appropriate response to structural and ecological factors rather than a pathology." Experimental work on the epigenetics of stress in humans and other organisms suggests an inverted U or J relation between stress and adaptive responses (Bernal et al. 2013; Park et al. 2017). This nonlinear relation between stress and adaptive responses can be called a "hormesis effect" (Chalk & Brown 2014). In the case of deprivation and epigenetics, evidence suggests that early exposure to extreme stress changes our epigenome in ways that place us at increased risk of disease. Swartz et al. (2017) show how DNA methylation is related to risk-linked amygdala activity, which would be adaptive in harsh environments, a finding that is consistent with P&N.

However, at extreme levels, these epigenetic changes may lead to depression or possibly suicide, which would likely be maladaptive, especially among older people, where community-based altruism may be beneficial to health in impoverished or low SES communities (Brown et al. 2005; Martinez et al. 2006).

In conclusion, present-oriented behaviours are adaptive in younger people for reproduction purposes; however, from an inclusive fitness perspective, grandparental investment is beneficial at older ages. This may help explain why even in older, deprived communities, altruism is positively correlated with health (Brown et al. 2005). Extreme present-oriented selfish behaviours may be strongly selected against among older individuals in deprived communities due to inclusive fitness losses or the costs of competing against younger individuals. Finally, experimental work on epigenetics in rodents (Bernal et al. 2013; Waterland & Jirtle 2003) clearly shows that *high* levels of stress *in utero* cause negative outcomes, whilst *moderate* levels of stress are beneficial. We do believe that a molecular epigenetic approach provides a useful extension to P&N's BCD approach. Age-dependent BCD can be tested using measures of developmental disruption at the molecular epigenetic (DNA methylation dysregulation as a barometer of stress, e.g., Horvath 2013; Park et al. 2017; Waterland & Jirtle 2003) and behavioural levels of analysis (e.g., prolonged sociopathy in older people). Manifestations of present-oriented behaviours in older people from deprived communities would be an example of pathology. In contrast, future-oriented altruism and giving social support (e.g., community volunteerism, especially among older people in impoverished communities; Brown et al. 2005) are expected to be more viable condition-dependent strategies relative to present-oriented behaviours.

From perceived control to self-control, the importance of cognitive and emotional resources

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Abstract: Pepper & Nettle (P&N) suggest that the poor present a "contextually appropriate response" to a perceived limited control and to a short life expectancy. We argue that differences in health, behavior, or impaired economic decisions are better explained by self-control. We discuss the implications of the differences between these perspectives and present supporting findings from two intervention studies with marginalized populations.

The "poor but neoclassical" approach treats poor people as utility-maximizing agents and focuses on the structural constraints that affect decision making as a consequence of reduced opportunities and incomplete information (Duflo 2006). Pepper & Nettle (P&N) offer an evolutionary take on this approach, arguing that a cluster of harmful behaviors linked to low socioeconomic status (SES) constitutes a "contextually appropriate response" to a perceived limited control and to a short life expectancy. In this comment, we substitute a different psychological explanation and argue that self-control rather than "extrinsic mortality risk" explains those behaviors. We propose that to be effective, interventions to guide disadvantaged populations should help participants develop a sense of competence and reduce the need for self-regulation.

We are in agreement with the authors' view regarding the impact of poverty, but we believe that many of their explanations about the mechanisms behind those behaviors are more readily explained by the well-established psychological construct of self-control and limited resources. For example, P&N argue that the actions of poor people are the outcome of environmental influences, which create a limited sense of control. However, wealthy people brought into a state of temporary deprivation have also exhibited myopia and made short-sighted decisions, regardless of their backgrounds or environments (Shah et al. 2012). These findings are explained by the limited attention span brought about by financial scarcity. According to this approach, being in a state of scarcity shifts the attention of the individual to whatever is currently lacking. This focus creates a cognitive load and exacts a price – the poor often fail to plan properly, tend to make inferior decisions, and pay too much attention to minor issues while neglecting more substantial financial aspects of their lives (Mani et al. 2013; Mullainathan & Shafir 2013; Shah et al. 2012).

Whereas the outcome of the scarcity approach concurs with that of P&N's view on the impact of poverty, it points to a different type of mechanism. Instead of emphasizing ecological factors and life circumstances that affect self-efficacy, this approach highlights the depletion of cognitive and emotional resources due to shortage of money. Although we do not intend to belittle the importance of environmental factors, evidence shows that the relationship is not as straightforward as the authors propose. For example, we discovered that SES is a poorer predictor than income of the financial distress of participants in an economic recovery program (Carmel et al., submitted). Moreover, it has been shown that environmental change programs for low-income populations obtain limited success: They positively influence well-being but have only a meager effect on wealth and employment (Ludwig et al. 2012).

The difference between a focus on limited "sense of control" and a focus on limited "self-control" is demonstrated by P&N's interpretation of extrinsic mortality risk. The authors suggest that "if people of lower SES feel that they are likely to be killed . . . it would make sense for them to invest less effort in looking after their health." This suggestion hints at a hidden assumption that the poor operate in a way that maximizes their utility, framing the authors' approach as part of the "poor but ne-classical" tradition. To support their assumption, the authors present the relationship between life expectancy and several inadequate behaviors that characterize individuals from low SES (e.g., an unwillingness to wait for future payoffs, health-related issues). However, alternative psychological explanations do not entail such an assumption. For instance, Bernheim et al. (2015) argue that poverty damages the ability to exercise self-control and can explain occurrences of harmful behaviors. Similarly, living in poverty demands trade-offs and permanent juggling between limited resources, resulting in a reduced ability to regulate behaviors (Loibl 2017; Vohs 2013). Those well-documented psychological explanations do not require the assumption of rationality. They acknowledge that vulnerable populations may be more subject to biases due to their stressful situations and obviate the idea that irresponsible behavior is a logical response to subjective expectations of life expectancy.

Finally, we would like to discuss the implications for interventions to help disadvantaged populations. We disagree with the authors' stress on extrinsic mortality, but we share their view regarding the importance of the locus of control. However, we consider it to be only the first step to recovery. Recently, we performed two independent intervention studies with marginalized populations who adopted the concept of mentoring to help their participants. The first was meant to evaluate the impact of a program among young immigrants. The program aims to reshape the lives of juvenile delinquents by offering them guidance, ongoing support, and personal attention. We found that the program managed to reduce recidivism by 17%, providing 10 times the return on investment (Spivak & Leiser 2016). The second study evaluated the impact of a financial intervention program meant to help families in financial distress. The study revealed that the program had a robust and long-lasting positive

impact on the participants' financial states (Carmel et al., submitted). Edelstein (2013), who has analyzed determinants of the achievements of the first program, concludes that sense of personal capability is a key ingredient to program success. Similarly, our assessment of the effectiveness of the financial program shows a positive relation between internal locus of control and the financial state of program graduates after 2 to 3 years. Interestingly, when asked about their difficulties, respondents in both studies mentioned self-control. Edelstein reports that the two main reasons for recidivism offered by past participants were temptations provided by their friends and environment and the lack of a supportive structure to help them fight those desires. Similarly, graduates of the financial intervention program mentioned that following the program's routine was a demanding task that they struggled to perform in the absence of the mentor. It appears that to make an impact, we should consider both factors – a sense of control to motivate people and a supportive environment to help them regulate their behavior.

Evolutionary approaches to deprivation transform the ethics of policy making

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Abstract: When designing public policies, decision makers often rely on their own behavioral preferences. Pepper & Nettle's (P&N's) theory suggests that these preferences are unlikely to be appropriate when applied to a different environment (e.g., a low-income environment with fewer career opportunities). This theory has profound implications for the design and ethics of public policies.

Behavioral approaches to public policies usually assume that public policies are needed because the human mind is biased through and through. This approach is especially appealing when it comes to dealing with populations from lower socioeconomic statuses (SES), who are construed as displaying such irrational behaviors as having children too early, underinvesting in education, or neglecting their health. Decision makers, who overwhelmingly originate from relatively high SES backgrounds, often apply their own intuitions when designing public policies and usually assume that the behaviors associated with deprivation are not really chosen and that public interventions nudging behavioral changes are necessarily positive.

In the article, Pepper & Nettle (P&N) rather contend that the "present-oriented behaviors of the constellation are a contextually appropriate response to structural and ecological factors, rather than pathology or a failure of willpower." In other words, people from poor backgrounds reproduce earlier not because they fail to *understand* the costs of their behavior, the benefits of education, or the way contraception works but because they actually have a different set of *preferences*. Put simply, different ecologies produce different preferences.

This perspective has profound implications for the way public policies are designed. Specifically, when relying on their own intuitions and behavioral preferences, policy makers produce cost-benefit analyses that are contextually appropriate responses to *their* contexts, which likely differ from those of the target population.

Take the example of early pregnancy. In 2014, 250,000 babies were born to women ages 15 to 19 years in the United States (Hamilton et al. 2014). A strong class gradient is associated with this phenomenon, suggesting that unfavorable SES conditions affect young women's sexual behavior (Penman-Aguilar et al. 2013). Confronted with these facts, and perhaps based on its own cost-benefit analysis, the public often makes two important assumptions: (1) Early pregnancies are not chosen, and women would delay childbearing if provided with adequate family-planning options; and (2) early childbearing is one of the main reasons why many women from poor backgrounds drop out of school, thereby depriving themselves of adequate training and, ultimately, of opportunities to earn decent wages.

Ethnographic and economic data suggest that these premises can be disputed. In their ethnography of young unwed mothers in poor Philadelphia neighborhoods, Edin and Kefalas (2011) describe how young women *choose* to have children early and illustrate their data with the poignant anecdote of a young pregnant woman who turns to the authors and asks: "Why is it so hard for people here to believe that the women would *want* their children?" (p. 183). These insights are further validated by sociological surveys indicating that poor women view childlessness as utterly tragic. Female high-school dropouts are indeed more than five times as likely to say that "childless people lead empty lives" compared to college-educated women (p. 204).

One might argue, however, that paternalism is justified, because these young women are blind to the enormous opportunity-cost that early childbearing entails. Against this view, research suggests that early pregnancies have a considerably lower impact on life outcomes for poor women than for middle-class women. Specifically, economists have demonstrated that the wage trajectory of low-skill women goes almost unchanged, regardless of whether they choose to have their first child in their early or mid-twenties versus in their early thirties. For high-skill women, on the other hand, the wage trajectory flattens out abruptly at the moment they start having children (see Figs. 2 and 4 in Wilde et al. 2010). According to the authors, a low-skill woman would gain as little as $20,000 (or 5% of lifetime earnings) by waiting 10 years compared to $125,000 (or more than 15% of lifetime earnings) for a high-skill woman.

To summarize, however strong our intuitions might be, early childbearing in underprivileged populations reflects stronger absolute preferences for having children and a relatively accurate assessment of the fact that early childbearing is associated with fewer forgone opportunities in low SES backgrounds. In line with P&N's argument, this set of evidence suggests that women are responding in a contextually appropriate fashion to the harshness of their environments and that early disadvantage might drive early childbearing and other negative outcomes.

This perspective has vital consequences when designing public policies. In particular, it suggests that targeting early childbearing by giving information about family planning, distributing contraceptives, or attracting women's attention to forgone training opportunities might have disappointing effects. In line with this idea, a recent Cochrane systematic review of randomized controlled trials targeting teenage pregnancy suggests that such interventions have small effects at best (Oringanje et al. 2016). Ironically, the review equates teen pregnancies and unintended pregnancies right from the title. Given limited public budgets, facilitating access to contraceptives may be the best we can do, but unless we target the lack of opportunities upstream, these initiatives are likely to have a limited impact.

The behavioural constellation of deprivation: Compelling framework, messy reality

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Abstract: Pepper & Nettle's (P&N's) argument is compelling, but apparently contradictory data are easily found. Associations between socioeconomic status (SES) and substance abuse are sometimes positive, the poor are sometimes eager to educate their children, and perceptions of local mortality risk can be so distorted as to constitute an implausible basis for contextually appropriate responding. These anomalies highlight the need for more psychological work.

Natural selection often favours risk taking and future discounting as facultative responses to cues indicating a relatively high risk of unpredictable, uncontrollable catastrophe (Daly & Wilson 2005; Promislow & Harvey 1990). Pepper & Nettle (P&N) make a powerful case that this insight illuminates many aspects of human development and behavioural variability, which we applaud. However, applying their model is not necessarily straightforward.

In support of their proposed "behavioural constellation of deprivation" (BCD), P&N (sect. 2, para. 4) posit "consistent" SES gradients in behaviours affecting health, one of which is that people of lower SES "are more likely to use illicit drugs and to drink excessive amounts of alcohol." Research in rich countries certainly supports this generalisation, but studies in Latin America contradict it. Researchers in Argentina (Fantin & de Barbenza 2007), Brazil (Baus et al. 2002; Macinko et al. 2015; Malta et al. 2014; Muza et al. 1997; Pratta & Santos 2007; Ramis et al. 2012; Silva et al. 2006; Souza et al. 2005; Souza & Martins 1998; Tavares et al. 2001), Chile (Florenzano et al. 2010; Peña et al. 2017; Sepúlveda et al. 2011), and Mexico (Caballero et al. 1999; Hernández & González 2013; Herrera-Vázquez et al. 2004) have repeatedly found SES to be positively associated with alcohol abuse, drug use, and smoking in adolescents and adults.

A partial reason for this discrepancy is that in poorer countries, the destitute lack the financial means to use and abuse substances, but there may be larger issues regarding how the BCD model can be applied in different contexts. There is meta-analytic evidence of greater variation in the relationship between SES and alcohol problems in low- to middle-income countries than in high-income countries (Grittner et al. 2012), suggesting that what constitutes deprivation may vary, too. In Latin America, adverse colonial legacies, enduring social injustice, and extreme economic and health inequalities (Andrade et al. 2015; Bambas & Casas 2001) have created situations in which the experience of deprivation is very different from in the rich world, and what constitutes a "contextually appropriate response" may also differ. P&N caution that the "deprivation" in their model refers to "the experience of various hardships" for which SES is only a "proxy," a caveat that is appropriate psychologically but problematic for measurement and comparisons. Moreover, how SES itself should be measured is controversial (Ensminger et al. 2003; Oakes & Rossi 2003; Wagstaff &Watanabe 2003), necessitating that we evaluate alternative measures before using SES even as a proxy.

In the target article's section 3.2, P&N explain that although responding to extrinsic mortality risk with future discounting is contextually appropriate, doing so can exacerbate one's mortality disadvantage, and such amplification even operates intergenerationally, further disadvantaging the children of the disadvantaged. How is it, then, that many people in the developing world are escaping this vicious cycle? Although the poor may sometimes see little value in educating their children, they often take the opposite view. Why one response rather than the other? Reduced infant mortality and family size, plus female labour-force participation, seem to be key variables, although the causal links are complicated and bidirectional (Gakidou et al. 2010; Goodall & Vorhaus 2011). Agencies trying to promote the prioritisation of education often target women as the most effective agents of change (Gakidou et al. 2010; Soares et al. 2010). Partly, this reflects a recognition that women are relatively likely to spend subsidies on their children and men on themselves, but it may also be the case that women are better prepared than men to adopt the longer view (Campbell 1999; Daly & Wilson 2005). Changes in child mortality and education (especially for women/girls) seem to be tightly linked, and shifts to longer time horizons can apparently occur quickly where policies support such change.

Evolved psychological mechanisms and processes are adapted to the past and do not necessarily promote fitness in novel environments. Internet pornography is avidly consumed, and motor vehicles evoke less fear than spiders. P&N are well aware of this issue, raising it implicitly in Section 7 and explicitly in Section 8.4, where they note that "[t]he BCD isn't necessarily adaptive and perceptions aren't necessarily accurate." Nevertheless, some earlier sections of the target article invite misconstrual as claims to the contrary. Indeed, the very phrase "contextually appropriate response" is open to such misconstrual; the claim of "appropriateness" is often warranted only with respect to the direction of responses, not their magnitude. In Section 2.3, for example, P&N quote a young offender who describes his Atlanta neighbourhood as a "war" zone in which "you never know if you gonna live one minute to the next." P&N continue, "[T]his may seem exaggerated, but . . . ," implying that it is not – but it is! In 2001, black males in "high-risk urban environments" in the United States had a life expectancy at birth of 66.7 years (Murray et al. 2005), a number only modestly affected by violent deaths and too high to justify, in and of itself, a belief that one has no future. But although the young offender's words exaggerate the dangers in his milieu, his sense of deprivation is fully justified: That 66.7-year life expectancy is lower than that of any other segment of the U.S. population. The crucial deprivation is *relative*, and it is unsurprising that people should have evolved to care profoundly about relative deprivation, because fitness itself is relative (Daly 2016). Statements like the young offender's abound in urban ethnographies, and the extent to which they represent braggadocio, a massive misperception of actual mortality risks, or something else remains unclear. Answering such questions is important, because they bear on the potential efficacy of providing better information.

A common denominator of these cautions is that the psychology of deprivation and risk preferences is not transparent, a problem compounded by sex differences and by the evolutionary novelty of modern environments. Applying P&N's valuable insights to the practical business of alleviating the social costs and self-destructive effects of the BCD will remain conceptually, as well as politically, challenging.

Beyond personal control: The role of developing self-control abilities in the behavioral constellation of deprivation

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Abstract: We agree with Pepper & Nettle that personal control is important in understanding people's willingness to engage in future-oriented behavior. However, this does not imply that self-control abilities play no role, for self-control abilities do influence whether individuals engage in future-oriented behavior. Personal control may also shape the development of self-control abilities, so contrasting the two may be a false dichotomy.

Why do people often behave in ways that are contrary to their best interests? Pepper & Nettle (P&N) ask this question while focusing on individuals of lower socioeconomic status (SES), who tend toward present-oriented behaviors that many would construe as maladaptive and indicative of poor self-control. P&N's answer is that this behavior does not result from a failure of willpower but instead originates from a rational, appropriate response to a lack of *personal* control: If people are less able to ensure they will receive future rewards, then it makes sense (logically and evolutionarily) to prioritize the present over the future in their behaviors.

We agree that contextual factors are important for understanding and addressing socioeconomic profiles of present-oriented behavior. Our work has highlighted the role of social norms and social trust: Children will delay gratification when they see that members of their own group do so (Doebel & Munakata 2017), and children and adults prefer immediate rewards when they believe those controlling the rewards are untrustworthy (Michaelson et al. 2013; Michaelson & Munakata 2016; see also Kidd et al. 2013; Lee & Carlson 2015). We have thus argued that present-oriented behaviors cannot be understood solely in terms of self-control abilities (i.e., willpower).

However, a full understanding of the "behavioral constellation of deprivation" (BCD) cannot discount self-control abilities in the way that P&N's account does. First, the ability to engage self-control does influence whether individuals engage in present-oriented behavior. For example, children who have worse self-control abilities at age 5 are significantly more likely to begin smoking, perform poorly in school, and engage in antisocial behaviors at age 12 compared to their twin siblings with better self-control, who are matched on nearly every aspect of the family environment, including SES (Moffitt et al. 2011). In addition, changes in self-control *within* an individual over time predict subsequent changes in academic achievement, but not vice versa (Duckworth et al. 2010). Moreover, some laboratory and classroom interventions suggest that short-term manipulations of self-control ability can influence present-oriented behavior (e.g., Bierman et al. 2008; Klingberg et al. 2005; Raver et al. 2011). Such findings from quasi-experimental and intervention studies highlight the importance of self-control abilities in avoiding the BCD. Personal control is not enough.

Second, contextual factors that influence willingness to engage in future-oriented behaviors may shape the development of self-control abilities, which in turn influence future-oriented behaviors. Thus, contrasting contextual factors with self-control may be a false dichotomy. For example, children from high-SES communities may experience many opportunities to practice self-control, due to such contextual factors as high personal control and social trust and the presence of social norms around self-control. Such experiences may themselves lead to greater abilities to control behavior and to neurocognitive substrates supporting self-control across the life span (Diamond 2012; Zelazo 2015). Moreover, such experiences may in turn lead to reciprocal, cascading effects (Karmiloff-Smith 1998; Sameroff 2009; Smith & Thelen 2003), whereby children who regularly practice self-control and see its benefits will increasingly value and use it. Thus, such experiences as these may substantially shape the development of self-control abilities. Such processes are consistent with the broader principles that P&N highlight regarding feedback loops that can amplify small initial disparities into large consequential ones. However, P&N focus on how such feedback loops can shape the *willingness* to engage in future-oriented behavior, whereas we highlight how such processes can also shape the *ability* to engage in such behavior.

Our account can provide insight into why childhood self-control predicts neural and behavioral indices of self-control in adulthood (Casey et al. 2011; Moffitt et al. 2011), and developmental links between SES and neural and behavioral indices of self-control (e.g., Hackman et al. 2015; Lawson et al. 2013; Noble et al. 2012). This account also suggests that targeted interventions that support early opportunities to practice self-control (e.g., by addressing social norms and trust that may support or inhibit self-control) can yield benefits. For example, children may be motivated to engage and practice self-control if they learn that self-control is valued in their community and leads to valued outcomes, and if they are provided with experiences of delayed rewards being delivered as promised. Considering learning processes and reciprocal, cascading effects in developing abilities to control behavior is essential for adequately addressing the complex ways in which contextual factors can shape the BCD.

Personal control and sociostructural inequalities clearly matter and are important targets. But concluding that self-control abilities do not matter is inaccurate and unnecessary. Self-control abilities influence present-oriented behaviors and may be one mechanism whereby small differences in present-oriented behavior get amplified into consequential ones. Thus, future work should address the processes that shape developing abilities to control behavior in the BCD and their distinct implications for intervention.

Toward a balanced view of stress-adapted cognition

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Abstract: Pepper & Nettle's paper exemplifies an emerging resistance against an exclusive focus on deficits in people who come from harsh environments. We extend their model by arguing for a perspective that includes not only contextually appropriate responses but also strengths – that is, enhanced mental skills and abilities. Such a well-rounded approach can be leveraged in education, jobs, and interventions.

> Deficit models dominate much of the psychological literature.
>
> – APA Task Force on Socioeconomic Status, 2007, p. 25

Pepper & Nettle (P&N) argue that exposure to uncontrollable disability and death leads people to value immediate rewards over longer-term goals. Whereas deficit models view this response as pathological, P&N consider it "contextually appropriate" – that is, understandable, given the context of hardships related to socioeconomic status (SES) in which people are operating. Their perspective is consistent with results from mathematical modeling in biology and cognitive science. Such modeling shows that when "the future's uncertain, and the end is always near" (The Doors 1970), individuals may benefit from seizing smaller, immediate rewards at the expense of investing in larger, later rewards (Ellis et al. 2012; Fawcett et al. 2012; McGuire & Kable 2013; Sims et al. 2013).

Despite a focus on appropriate responses to external context, P&N fully acknowledge that harsh conditions can lead to deficits (e.g., due to neglect or poor nutrition), and so do we (Ellis et al. 2017; Frankenhuis & de Weerth 2013). However, deficit models are not the whole story. Contextually appropriate responses may also include the development of *enhanced skills and abilities* that are ecologically relevant in harsh, unpredictable environments. Here, we focus on such skills and abilities, which have only recently become a target of investigation, so we know little about them. Initial findings, however, are promising (for review, see Ellis et al. 2017; Frankenhuis & de Weerth 2013). We focus specifically on the skills and abilities needed to make

the most of a world that is difficult to predict and control (Frankenhuis et al. 2016; Mittal et al. 2015). What protean skills and abilities might we expect in such a continually changing world?

The short answer is: It depends. What aspects of the environment are unpredictable and uncontrollable – the home, school, neighborhood, country, or all of these – and to what extent? Is there some social support that can be relied on? Barring such nuances for now, let us consider the poorest and most chaotic inner-city areas, in which there is generally little scope for predicting and controlling outcomes in multiple life domains, including health, work, and love.

We distinguish between "specialization" and "sensitization" effects (Ellis et al. 2017). "Specialization" occurs when repeated developmental exposures to a stressor improve attention, perception, learning, memory, and problem solving relevant to this stressor across a variety of contexts (Frankenhuis & de Weerth 2013). "Sensitization," in contrast, occurs when skills and abilities manifest only in currently stressful contexts that match the contexts in which the stressor has normally been encountered (e.g., Dang et al. 2016; Mittal et al. 2015).

When opportunities are sparse and fleeting, people should be extra-attentive to them (Nederhof et al. 2014). Although we are not aware of studies directly testing this assumption, two recent studies do suggest that stress-adapted people develop enhanced abilities for flexibly switching between tasks or mental sets. Consistent with specialization, Vandenbroucke et al. (2016) find enhanced response shifting in Belgian children from low-SES backgrounds (but see Obradovic 2010). Consistent with sensitization, Mittal et al. (2015) observe enhanced attention shifting in U.S. adults from unpredictable backgrounds when they were experimentally put into a mind-set of economic uncertainty. In this mind-set, people exposed to high childhood unpredictability also displayed enhanced aspects of working memory central to tracking novel environmental information (Young et al., under review).

When encountering short-term rewards, people from harsh environments might show enhanced abilities for procuring them. Consistent with specialization, Suor et al. (2017) report enhanced reward-oriented problem solving (e.g., gaining access to an attractive toy encased in a transparent box) in four-year-old U.S. children with bold temperaments from low-SES backgrounds. These same children, however, displayed reduced performance in an abstract visual problem-solving task similar to the kinds of tests administered in schools. Thus, bolder children from low-SES backgrounds might develop enhanced reward-oriented problem-solving skills for gaining access to immediate rewards, which may trade off against abstract problem-solving skills.

So far, we have discussed (a) shifting between tasks and mental sets, (b) tracking novel environmental information, and (c) exhibiting persistence in procuring immediate rewards. What about learning new contingencies? Consistent with sensitization, Dang et al. (2016) report that when they were experimentally put in a mind-set of high financial demand, lower-SES Chinese students showed enhanced procedural learning (i.e., acquiring novel stimulus–response associations) compared with their higher-SES counterparts. Other work shows that in such a mind-set, community samples from the United States and India showed reduced performance on cognitive functions that rely heavily on working memory (Mani et al. 2013). An interesting and open question for future research is to determine which components of working memory can become enhanced and which impaired by exposure to specific forms of adversity.

Traditional deficit models consider individuals from harsh backgrounds to be at risk for impaired development, and the intervention goal is to reduce or repair the damage. Following Ellis et al. (2012), P&N critique this approach by arguing that present-oriented behaviors are a "contextually appropriate response to structural and ecological factors, rather than pathology or a failure of willpower." Ellis et al. (2017) take this critique one step further by arguing that deficit-based intervention approaches fail to leverage the unique strengths and abilities that develop in response to high-stress environments. Uncovering a high-resolution map of these "hidden talents" would enable the design of classroom environments, instructional strategies, and job training to work with, instead of against, the capacities of stress-adapted people (see Ellis et al. 2017 for detailed illustrations), enabling a wider range of individuals to achieve their full potential.

In conclusion, we propose to extend P&N's model by arguing for a well-rounded perspective on stress-adapted cognition, which includes deficits, contextually appropriate responses, and strengths (i.e., enhanced skills and abilities). Our perspective has scientific merit for its completeness and societal value for its ability to inform a class-conscious psychological science that attends to social-structural inequalities (see Geronimus 2013). It underscores the unique skills and abilities that develop in high-adversity contexts and that can be leveraged in policy and practice to better fit the needs and potentials of stress-adapted people.

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What about the behavioral constellation of advantage?

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Abstract: Many short-sighted behaviors are more common among poorer people. These behaviors are neither evolutionarily nor historically unusual and have strong contemporary encouragement. The bigger puzzle is their lower frequency among the affluent. The behaviors also have clear cultural and normative aspects that limit the usefulness of strictly individualist theories.

Poor people are disproportionately likely to make various choices that appear obviously counter to their long-run interests. These include decisions regarding finances, childbearing, parenting, recreation, and health; Pepper & Nettle (P&N) collect various examples that they call the "behavioral constellation of deprivation." Bad choices make poor people easy to pathologize as chronically undone by a lack of intelligence or impulse control. Against this view stand efforts to recast these choices as, in one way or another, reasonable responses to the deprivations that low-socioeconomic-status (SES) people confront in their everyday lives: In P&N's parlance, as a "contextually appropriate" response.

Implicit throughout P&N's argument is that premise that the behaviors associated with lower SES pose a puzzle. What cannot be emphasized enough is how dependent this puzzle is on the perch from which academics observe it. In truth, we – not poor people – are the weird ones. From an evolutionary perspective, many commonplace high-SES behaviors in developed societies, from long-delayed first pregnancy to voluntary low fertility to regular recreational exercise to deliberately abstemious diets, are downright peculiar. As more recent history, SES differences in several behaviors P&N cite – smoking, breastfeeding, age at first birth – have emerged more from changing behavioral patterns among high-SES individuals than low-SES individuals. For example, in the United States, little SES difference in smoking existed until rates began dropping among higher-SES individuals, creating a gap as rates among lower-SES individuals declined more slowly (Link & Phelan 2009).

The behaviors identified by P&N surely exacerbate challenges that poor people confront. Yet what we recognize as the social policy problem is not necessarily the most productive way to

view the scientific problem. We should not treat the behaviors of the affluent as providing the natural baseline from which different behaviors by low-SES people are to be explained. If the question is what would get low-SES people to behave more like high-SES people, even for policy purposes, it is unclear whether the answer is to be found in the specifics of their lives versus ours. How is it that higher-SES individuals have become so far-sighted and so watchful of long-term health? Why do so many refrain from short-term rewards well beyond any reason for which there is a clear indication of long-term benefit?

That short-sighted behaviors are puzzling becomes even more questionable when we think about contemporary environments surrounding choices. It hardly takes a tie-dyed critic of capitalism to notice the enormous environmental pushes encouraging behavior against long-term interests. The rise of smoking famously involved the systematic marshaling of an enormous agricultural, physiological, political, and marketing knowledge to get hundreds of millions worldwide hooked (Brandt 2009). Smoking's decline among high-SES individuals occurred in the face of this, and only subsequently did this transform into various increasingly coercive measures to push lower-SES individuals to follow their lead. Lesser variations on this theme lurk behind other products connected to behaviors highlighted by P&N: opioids, fast food, soda, infant formula, machine gambling, usurious credit cards. Low-SES people in developed societies exist at a nexus of manipulation in which vast enterprises devise ever-more-inviting traps of immediate gratification, while academics and others devise interventions to discourage these same behaviors.

P&N's focus on risk and control leads them to overstate the individuality of decisions. Many behaviors noted by P&N are plainly subject to social influence, or even to collective decisions. As examples: Trajectories of smoking, alcohol, and drug use notoriously often involve groups of users; social transmission contributes to obesity; exercise experts regularly tout the adherence advantages of "working out with a buddy"; and parental investment regularly involves joint decision making by parents and a good deal of kibitzing and mimicking of others.

Indeed, one of the most consequential things about SES is how it connects individuals in social space, so that individual choices reflect and reverberate through networks of others with disproportionately similar statuses. Even today, a low-SES person who wants to quit smoking still likely has many more fellow smokers in his or her life than a higher-SES smoker who wants to quit. Behavioral tendencies may be pervasively amplified by the choices of others with similar tendencies. To this end, one might be skeptical of the prospects of a theory of SES differences in behaviors that focuses so much on individuals and so little on relationships and networks. These behaviors clearly have cultural and normative aspects: If you do not believe so about smoking, try lighting up in a faculty meeting and see what happens.

P&N's emphasis on risk and control may also lead them to sometimes present poor people as more powerless than they are, especially in ways in which their argument draws on evolutionary history. For instance, a key example in their argument involves the homicide risk facing youth in poor urban neighborhoods, where "your risk of being a victim of homicide is relatively high" (target article, sect. 2.3, para. 3). These youth do face a homicide risk many times higher than that of affluent kids from the suburbs, but it should also be recognized that the mortality risk to low-SES youth today is substantially lower than that of a woman dying in childbirth any time before the nineteenth century. Moreover, P&N characterize homicide for those stuck in poor neighborhoods as being a "risk beyond [their] control," so much so that "there may seem little point in quitting smoking or eating healthy foods, because you may not live" (sect. 2.3, para. 3). In the United States, at least, homicide victimization in such neighborhoods is, in fact, highly disproportionately concentrated among youth with significant histories of criminal or gang activity (Papachristos et al. 2015). Low-SES youth certainly have much more control over avoiding death from homicide than women historically have had from avoiding death in childbirth. Poverty presents enormous challenges, but we should be wary of casting the lives of the poor as but a small step removed from *Mad Max*.

The physiological constellation of deprivation: Immunological strategies and health outcomes

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Abstract: Physiology and behavior are best thought of as two aspects of the same biological process, shaped simultaneously by natural selection. Like behavioral strategies, ecological conditions may affect physiological strategies, leading to changes in immunity and hormonal regulation. These alternate strategies help explain the health correlations of deprivation and provide additional pathways for feedback from early-life experiences.

Pepper & Nettle (P&N) focus on the behavioral constellation of deprivation (BCD) and provide a useful framework for understanding why certain behaviors persist under conditions of deprivation. Within this framework, they also touch briefly on physiological mechanisms related to and contributing to the BCD and its health outcomes. They note that, on average, individuals experiencing deprivation have worse health across multiple domains and suggest that this may be due to "double disinvestment" in physiological repair and behavioral investments in health. This suggestion makes sense, but it may be an oversimplification; development in a deprived environment may lead to not just *disinvestment* in repair and immune mechanisms but also *investment* into alternate kinds of immune defense and repair.

In section 4.4, P&N briefly consider how early-life stressors are associated with increased pro-inflammatory responses and mention research by Miller et al. (2011) suggesting that pro-inflammatory tendencies can become biologically committed through developmental processes, such as epigenetic modification. What P&N do not mention is that Miller et al. propose that this increase in inflammation might represent a predictive adaptive response that evolved in ancestral environments in which uncertainty was coupled with greater risks of injury and illness. In such circumstances, an elevation of inflammatory responses might be adaptive, despite potential costs to long-term health and survivability.

Expanding on similar ideas, it has been suggested that different types of immune response can be thought of as having different costs and benefits that vary with life history and socioecological variables (Blackwell et al. 2016; Demas & Nelson 2012; McDade et al. 2016; Sheldon & Verhulst 1996). We can conceptualize immunity as being composed broadly of innate and adaptive components that differ in their utility and cost. Innate components are the body's first-line response to a foreign pathogen, but they are not directed toward specific strains or species of pathogens (e.g., some of the responses commonly referred to as "inflammation"). These responses require fewer start-up costs, as they are preexisting and so can respond immediately to a threat. Alternately, adaptive responses are components that are acquired during a lifetime and are directed at the particular pathogens an individual has encountered. Adaptive immunity requires time to develop; for example, after a new infection, it may take a week or two to gain full adaptive immunity. At the core, then, the

costs of innate and adaptive immunity differ in their time schedules, and if time is short, a stronger innate response might be preferred (Martin et al. 2007). Adaptive responses also require the production and maintenance of large pools of naïve cells, randomly generated variants that may or may not match an actual antigen, and thus require continuous energetic investment. Therefore, such factors as nutritional abundance, pathogen exposure, and extrinsic mortality risk should interact to determine optimal investment in innate versus adaptive immune defenses, given the relative costs and benefits of different kinds of immunity (McDade et al. 2016).

Without belaboring the details, these shifts may help explain some health correlates of deprivation, in particular the incidence of chronic diseases, such as cardiovascular disease and diabetes. Inflammation contributes to these diseases by causing collateral damage in the body. However, because this damage may not have effects for many years, when extrinsic mortality is high, it may not pay to avoid it, given the short-term benefits.

The regulation of these alternate immunological strategies may also be tied to regulatory mechanisms related to stress and metabolic function. As P&N note, aspects of social deprivation and stress have consistently been linked to chronic alterations in hypothalamic–pituitary–adrenal (HPA) activity. A number of cells and signaling molecules of the immune system, particularly those implicated in inflammatory processes (e.g., IL-1β, IL-6, and TNF-α), have complementary, although inverse, diurnal rhythms to cortisol (Cermakian et al. 2013; Chrousos 2000). Under "healthy" conditions, there appears to be tight crosstalk between the circadian rhythms of these systems (Petrovsky 2001). However, chronic HPA stimulation can lead to loss of rhythmicity and diurnal blunting for cortisol and pro-inflammatory cytokines. Thus, the regulation of immunological strategies is tightly linked to broader mechanisms for regulating physiology and behavior in response to stress.

Finally, we should expect that as individuals become committed to particular immunological strategies during development, they may need to make corresponding behavioral adjustments to match their physiological conditions. Individuals monitor and make assessments based on their own physiological states; for example, self-rated life expectancy and self-rated health are reliable predictors of mortality risk, independent of objective measures (Siegel et al. 2003). It is likely that the same signaling molecules that regulate immunity, such as cytokines and cortisol, also convey information to the central nervous system. Such signals are clearly implicated in sickness behavior and depression (Shattuck & Muehlenbein 2015; Stieglitz et al. 2015) and might plausibly have more subtle effects on present-oriented behaviors. Thus, physiological commitment may be an important constraint, creating further feedback mechanisms that reinforce the BCD.

Predictability or controllability: Which matters more for the BCD?

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Abstract: Pepper & Nettle's theory of the behavioral constellation of deprivation (BCD) would benefit from teasing apart the conceptually distinct – although related – constructs of predictability and control. Our commentary draws from prior research conducted in the learning domain to demonstrate that predictability moderates the effects of control and independently exerts a powerful influence on outcomes relevant to the BCD.

Pepper & Nettle (P&N) provide evidence that lower socioeconomic status (SES) gives rise to a cluster of behaviors – coined "the behavioral constellation of deprivation" (BCD) – that represent contextually appropriate, adaptive responses to the heightened extrinsic mortality and health risks inherent in such conditions. A key feature of P&N's argument is that lower SES engenders limited control over future outcomes. This lack of control reduces the likelihood of realizing delayed rewards, favoring present-focused behaviors.

We appreciate the body of literature demonstrating that inability to control the future contributes to the development and expression of the BCD. However, in much of the research cited here and elsewhere, lack of control is often confounded with unpredictability (e.g., Kidd et al. 2013), which is a related but distinct construct (Koolhaas et al. 2011; Mineka & Hendersen 1985; Nickels et al. 1992). Similar to lack of control, unpredictability is a defining feature of low-SES environments (Mittal & Griskevicius 2014; Ross & Hill 2002) and plays a key role in shaping physiological responses to environmental stressors (for review, see Koolhaas et al. 2011). However, the two are distinct constructs, and research examining the unique contributions of each in the development and expression of behaviors consistent with the BCD suggests that environmental unpredictability may be the key driver of these effects. We review this literature below.

The first reason we propose that unpredictability – rather than uncontrollability – drives the BCD is because an outcome's predictability influences one's perception of control over it. Unpredictable events are perceived as more uncontrollable (Glass & Singer 1973; Nickels et al. 1992; Wortman 1975). For example, research has found that individuals subjected to unpredictable – but not predictable – noise blasts exhibited a reduction in perceived control over noise onset, in addition to frustration and impairments in cognition (Glass & Singer 1973). Others have found that participants reported having more influence over exposure to predictable – compared to unpredictable – noise cycles, regardless of whether the participant actually had control (Nickels et al. 1992). Unpredictability's capacity to reduce perceived control is further supported by research examining its role in promoting outcomes associated with the BCD, such as the development of an external locus of control, increased risk taking, and impulsivity (Ross & Hill 2002).

In line with the role that unpredictability plays in shaping one's perceptions of control, one's actual ability to control one's environment depends on the predictability of outcomes available therein (Badia et al. 1979; LaDage 2015; Weiss 1971). Indeed, the advantage of being able to behaviorally control an event is lost if one cannot reliably expect when associated rewards or consequences will arrive. For example, Weiss (1971) has found less gastric ulceration (a key stress maker) in rats that could escape or avoid shock compared to those that could not, exhibiting the benefit of control. However, even within the group of rats that could exercise control, higher levels of ulceration were found when the onset of the shock was unpredictable than when it was preceded by a signal. Others have found that escape and avoidance behaviors (i.e., attempts to control exposure) were reduced when onset of an aversive stimulus was unpredictable compared to stimuli preceded by a signal (Badia et al. 1979; Dess et al. 1983; Galhardo et al. 2011). This appears to result from a learned irrelevance between one's behavioral attempts to control an event and its onset, perhaps analogous to unpredictability's impact on the perception of control in humans (Glass & Singer 1973; Nickels et al. 1992; Overmier & Wielkiewicz, 1983; Wortman 1975). Together, this research suggests that unpredictable events cannot truly be controlled. Therefore, many of the benefits associated with control over future outcomes are erased when those outcomes are temporally unpredictable.

Last, it is important to note that outcome predictability is capable of attenuating the harmful effects of limited control. Being able to predict stressful events decreases how stressful they are, even when one has no control over them (Badia et al. 1979; Dess et al. 1983; Grillon et al. 2006; Martf & Armario 1997). For example, Martf and Armario (1997) have found that the pituitary-adrenal response of rats became habituated to predictable – but not unpredictable – noise. This suggests that predictability may blunt the stressfulness of unpleasant situations by promoting habituation. Further, predictability can reduce the stressfulness of aversive stimuli by signaling safety, also known as the "safety signal hypothesis" (Seligman & Binik 1977). For example, when a shock arrives predictably, the end of exposure indicates a period of safety that allows for recovery from the previous trial and preparation for the next (Mineka & Hendersen 1985; Seligman & Binik 1977). However, when the stimulus is administered unpredictably, safety is never signaled, enhancing anxiety and hypervigilance (Dess et al. 1983; Herry et al. 2007; Schmitz et al. 2011; Wieser et al. 2016). This pattern is also observed in the context of food delivery (e.g., Fokidis et al. 2012; Waitt & Buchanan-Smith 2001). Research in birds has found that when similar amounts of food were presented either predictably or unpredictably, unpredictable delivery was associated with reduced body mass and an increase in circulating glucocorticoids compared to predictable delivery (Fokidis et al. 2012).

In summary, we agree that control is a crucial element in determining how individuals respond to the risks in their environments. However, we argue that the ability to predict the future may be a more fundamental factor in facilitating the BCD than control, per se. We propose that considering the contribution of unpredictability to these outcomes could further add to the predictive power of P&N's model.

Divergent life histories and other ecological adaptations: Examples of social-class differences in attention, cognition, and attunement to others

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Abstract: Many behavioral and psychological effects of socioeconomic status (SES), beyond those presented by Pepper & Nettle cannot be adequately explained by life-history theory. We review such effects and reflect on the corresponding ecological affordances and constraints of low- versus high-SES environments, suggesting that several ecology-specific adaptations, apart from life-history strategies, are responsible for the behavioral and psychological effects of SES.

Pepper & Nettle (P&N) use a life-history framework to integrate a large body of work on psychological consequences of socioeconomic status (SES). They argue that many behaviors that at first appear irrational or self-destructive are, in fact, adaptive responses to the ecologies faced by low-SES people. We agree that such differences likely are adaptive responses to ecological conditions. However, we note that P&N have restricted their focus to a small range of SES-related findings, thereby missing an opportunity to integrate a larger literature on social-class differences in psychological phenomena. We propose that ecological and evolutionary frameworks provide key explanations for how the broad range of social-class differences represent adaptations to particular ecological threats and affordances. Such explanations include but are not exclusive to life-history strategies.

SES systematically affects a wide range of psychological and behavioral phenomena beyond those discussed in the target article. These effects involve different attentional foci, reasoning, and attunement to others. We briefly review this body of literature and propose how these SES-linked differences may reflect adaptations to different ecologies.

Many studies suggest that lower-SES people are relatively more attentive to contextual information than those who are of higher SES, as demonstrated on tasks concerning the reproduction of abstract shapes (Grossmann & Varnum 2011) and memory recall (Na et al. 2010). Beyond differences in attention, there is evidence of SES differences in types of inferences people draw from their environments. Some of this evidence concerns reasoning about causality, revealing that when compared to higher-SES individuals, lower-SES individuals are more likely to explain their behavior in terms of environmental constraints rather than intentions or stable dispositions (Grossmann et al. 2012; Grossmann & Varnum 2011; Kraus et al. 2009). Recent work also suggests that lower-SES people are also more likely to employ nonlinear, dialectical reasoning when predicting change in the trajectory of social (Na et al. 2010) and societal events (Grossmann & Varnum 2011).

Studies have also revealed SES differences in the degree to which people are attuned to others. Lower SES is associated with a greater likelihood of defining one's self and personal goals through relationships with others (Grossmann & Varnum 2011; Stephens et al. 2011; Stephens et al. 2014). It is also associated with greater accuracy in determining (Kraus et al. 2010) and showing compassion toward others' emotions (Stellar et al. 2012). Eye-tracking studies show that low-SES individuals are more likely to focus on other people in their environments (Dietze & Knowles 2016). Consistent with behavioral studies, EEG/ERP studies assessing neural responses to other emotions and movements suggest that lower-SES individuals show heightened responses to others' expressions of pain (Varnum et al. 2015) and that their mirror neuron systems appear to be more reactive to others' actions (Varnum et al. 2016). Both of these effects may be useful from the standpoint of self-protection. Indeed, consistent with this idea, recent fMRI studies have suggested enhanced vigilance to threats among those of lower SES (Gianaros et al. 2008; Muscatell et al. 2012).

Why might social class have these effects on processes ranging from neural responding to attention to reasoning about causality? We propose that these differences reflect adaptations to specific features of low- versus high-SES ecologies. Lower-SES ecologies are characterized by numerous threats, including resource scarcity, physical dangers, and greater prevalence of infectious decease. Under such circumstances, broader patterns of attention may be adaptive, helping people identify threats and spot fleeting resources and opportunities (Gallo et al. 2005; Taylor & Seeman 1999). Second, lower-SES ecologies are characterized by greater unpredictability. Thus, more dialectical forms of reasoning, which acknowledge the role of uncertainty and view processes in a nonlinear fashion (Grossmann, in press), may provide better guidance for decision making in such environments (Grossmann 2017; Grossmann et al. 2017). Third, when reasoning about the causes of others' behavior in a setting of limited and feeling resources and a wide range of threats, one would arrive at more accurate inferences and predictions by giving greater weight to external causes (Stellar et al. 2012). Finally, to avoid or better cope with potential threats common in low-SES environments, one may become more attuned to other people, including their feelings, intentions, and actions, enabling efficient in-group coordination of threat-specific responses (Pickett & Gardner 2005; Taylor 2006). Given a backdrop of scarcity, these attentional, cognitive, and social strategies are of greater survival relevance for lower- versus higher-SES people. Beyond vigilance to and

management of threats and uncertainty, greater attunement to others may also help alert individuals to potential mating opportunities, consistent with a faster life-history strategy. However, life-history theory alone cannot sufficiently account for SES differences illustrated here, including differences in nonsocial attention, dialectical reasoning, and many features of social attunement (e.g., self-definition through relationships with close others).

To conclude, a serious consideration of ecological affordances and constraints may provide a framework to understand not only SES-linked differences in behaviors linked to short- versus long-term focus but also a range of other tendencies that have been shown to vary as a function of SES. Although life-history provides a powerful lens to understand how social class shapes some aspects of cognition and behavior, we do not believe that life-history theory allows for ready explanations of a range of other ways in which those who are of higher versus lower SES differ. There are numerous ways in which SES differences may reflect ecology-specific adaptations. A complete account of how social class shapes minds and behavior must address ecological adaptations (Grossmann & Varnum 2015), the sociocultural environments they create (Grossmann & Huynh 2013; Kraus et al. 2011; Stephens et al. 2011), and the interaction of ecological and cultural factors with processes discussed by P&N's model.

Uncertainty about future payoffs makes impatience rational

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Abstract: Uncertainty (i.e., variable payoffs with unknown probabilities) brings together a number of features of the authors' argument. It leads to present bias, even for completely rational agents with time-consistent preferences. As an evolutionary product of Pleistocene climate instability, humans possess broad adaptations to environmental uncertainty, giving rise to key features of the behavioral constellation of deprivation (BCD).

Pepper & Nettle's (P&N's) article is an important contribution to a growing body of research that shows that poor people frequently make very sensible choices, given the enormous constraints that they generally face (Banerjee & Duflo 2011; Collins et al. 2010; Mullainathan & Shafir 2013; Nettle 2010a). It is exciting to see further integration of life-history theory with the study of poverty and the conditions of deprivation (Jones 2015), especially coming from some of the leaders of the study of life-history decisions among contemporary people (Nettle 2010a).

P&N do not specifically discuss uncertainty, but it is central to the lack of control that lies at the heart of the behavioral constellation of deprivation (BCD) and is, in all likelihood, the force that shaped the evolution of the constellation itself (Jones 2011; 2015). In the decision-theoretic sense, "risk" is defined as a variable reward, as might arise through a lottery. Risk implies known probabilities of the potential payoffs. "Uncertainty," on the other hand, implies that the probabilities of the variable rewards are not known. Indeed, the very outcome of the decision might not be known (Knight 1921).

Temporal discounting is a way of accounting for time preferences. P&N present ample evidence for a preference for immediate rewards in the BCD. But two key features of discounting need to be explained by any theory of time preference: the overall magnitude of temporal discounting and the shape of the discount function. The contextually appropriate response (CAR) hypothesis makes a clear prediction about the magnitude of discounting, but it is less clear about the shape of the discount function. This is an area where a focus on uncertainty helps fill a theoretical gap. Higher discount rates will lead to a strong preference for immediate rewards, consistent with CAR. The shape of the discount function – how discounting changes with time – is a distinct phenomenon. The orthodox theory of economic choice, based on the maximization of expected utility, requires a constant discount rate. This constant rate in continuous time leads to an exponential discount function, and this particular form is crucial for expected utility theory, because only an exponential discount function will lead to dynamic consistency (i.e., in the absence of new information, preference orderings at the outset will remain consistent as time proceeds). A substantial empirical literature suggests that people frequently violate the expectation of constant time preference (Ainslie 1975; Herrnstein 1961; Laibson 1997). People are typically anchored in the present: Any delay from the immediate is discounted steeply. However, as time passes, they show decreasing impatience. The apparent discount rate declines over time as people become indifferent to small delays in the more remote future. This pattern of discounting is typically referred to as "hyperbolic," although a more descriptive term is "present bias/diminishing impatience" (PB/DI).

Starting with Ainslie (1975), PB/DI was generally interpreted as a failure of willpower, because small rewards with short waiting times can be favored over larger rewards with longer waiting times, even if the larger rewards are initially favored. Many of the sensation-seeking features of the BCD have been linked to this putatively irrational, time inconsistency (Bernheim et al. 2015; Loewenstein 1996). However, recent work incorporating uncertainty into the theory of time preferences suggests that PB/DI can arise in rational agents when the future is uncertain and information available for learning about the future is limited (or very costly to acquire). Yaari (1965) notes that mortality hazard could mimic the effect of a pure time preference. Sozou (1998) notes that the constant time preference of expected utility theory is formally equivalent to an agent's having a prior distribution for failure times with an exponential hazard. He further shows that integrating across uncertainty in this otherwise time-consistent framework naturally leads to PB/DI. The clear conclusion from a number of authors, using a variety of formal models, is that uncertainty leads to PB/DI, even if the underlying intertemporal preferences are consistent (Dasgupta & Maskin 2005; Halevy 2008; Jackson & Yariv 2014; Sozou 1998).

There is a surprising lack of empirical evidence on the association between deprivation and differences in the shape of discount functions. However, the association between PB/DI and uncertainty potentially provides an important avenue for future empirical and experimental work. People with greater uncertainty should be more present-biased in addition to having higher discount rates overall.

I have suggested that the unusual features of the human life cycle (late age at first reproduction [AFR] coupled with high fertility, overlapping periods of dependence, extensive alloparental care, and postreproductive survival) are consistent with adaptations to extreme environmental variability (Jones 2005; 2011). In brief, stochastic demography (Tuljapurkar 1990) shows that variance in vital rates induced by environmental variation is generally bad for fitness, and, when the variance primarily affects juvenile survival, the negative effects are modulated by generation time. Longer generation times (which arise from late AFR and long reproductive spans) smooth over environmental variation, reducing the negative effects. Selection is therefore expected to lengthen the life cycle and lead to bet-hedging reproductive tactics (Jones 2011). The origin of the genus *Homo* and the evolution of modern *H. sapiens* are associated with a broad cooling and drying of the planet and, especially, periods of substantial environmental instability that have, at times, been extremely high frequency (Anklin et al. 1993; deMenocal 1995; 2004). Humans

are adapted to a cool and unpredictable planet; as such, we should expect substantial adaptations to managing uncertainty. This highlights the potential importance of the BCD for understanding human life histories in general – not simply in industrial nation-states – and the central role that uncertainty has played in shaping these adaptive responses.

The uncontrollable nature of early learning experiences

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Abstract: Early learning experiences shape the development of the behavioral constellation of deprivation (BCD) proposed by Pepper & Nettle (P&N). There is considerable variability in early learning experiences across diverse socioeconomic status (SES) backgrounds, particularly when it comes to language. Here, we discuss how early learning experiences are beyond the control of the individual and subsequently contribute to behaviors in P&N's constellation.

Differences in behaviors across socioeconomic status (SES) backgrounds have been well documented across disciplines. Indeed, psychologists have witnessed higher incidences of mental health problems in individuals from low-SES backgrounds (Barrett & Turner 2005; Williams et al. 1997), educators have noted significant achievement gaps between children from low-SES and mid-SES backgrounds from early ages (Wagner 2014), and neuroscientists have found differences in neural processing across SES groups (Hackman & Farah 2009; Shonkoff 2011).The full set of underlying mechanisms associated with such differences remains unclear.

In their behavioral constellation of deprivation (BCD), Pepper & Nettle (P&N) propose a contextualized model for the behaviors surrounding deprivation. Such behaviors appear to be deeply rooted in the notion that individuals from low-SES backgrounds are more present-oriented due to the lack of control associated with lower SES. Given the "uncontrollable" faced by individuals from low-SES backgrounds, we argue that an important factor that influences the BCD is the early learning experiences of all individuals, including those from low-SES backgrounds.

Early learning experiences largely shape later behaviors. A virtuous cycle of learning occurs for children who have access to the type of numerous, rich, and varied experiences that support acquisition of knowledge about the world – evidence suggests that access to knowledge through such experiences contributes substantially to later reading achievement and school success (Storch & Whitehurst 2001). Yet not all children have the opportunity to engage in the types of activities that lend themselves to new knowledge; variability in such access is associated with large and early gaps in conceptual knowledge (Neuman & Celano 2006), vocabulary (Fernald et al. 2013), and information-seeking behaviors (Chouinard et al. 2007; Kurkul & Corriveau 2017).

Children learn about the world in a variety of ways – through solitary exploration, through firsthand experiences, and by seeking information from others. We argue that variability in information seeking may account for part of the variability observed in differences by socioeconomic background. Before children are 12 months old, all children can seek information from others by engaging in social referencing (Walden 1993); attending to head direction, body posture, and eye gaze to understand the focus of adults' attentional focus (Brooks & Meltzoff 2005; 2014); and using pointing as a means of soliciting parental attention to an object of interest (Butterworth 2003; Camaioni et al. 2004). Yet the extent to which the parent feels it is culturally appropriate or is willing to engage in one-on-one direct-instruction learning experiences remains out of the child's control. For example, when a child is born into circumstances of deprivation, the parent might not be emotionally or physically available, and so the child might not turn as readily to the parent for guidance. This pattern often continues until children reach formal schooling, at which point children's communication patterns are already well established. Indeed, not only are children from low-SES backgrounds exposed to fewer words than their middle-class peers during their preschool years (Blum-Kulka 1997; Hart & Risley 1992; 1995; Heath 1983), but also; their parents use more directive speech and less sophisticated vocabulary (Rowe 2012; Rowe et al. 2005) and explanations (Kurkul & Corriveau 2017). Early exposure to these communication patterns not only influences children's language acquisition, but also is likely to influence how children acquire new knowledge and make judgments about the credibility informants (Corriveau et al. 2016).

In two recent studies, we found that children from low-SES backgrounds assess explanations differently than their mid-SES peers. In one study, we explored the question-explanation follow-up pattern of interaction that is often used by children to acquire new information (Kurkul & Corriveau 2017). As was consistent with previous findings, children from mid- and low-SES families asked a similar proportion of fact-based (e.g., "who," "what," "where") and causal (e.g., "how," "why") information-seeking questions. Regardless of SES groups, parents generally provided satisfactory responses to children's fact-based questions. However, differences were found in the types of responses children from low-SES families received to their causal questions when compared to their mid-SES peers. Parents from low-SES backgrounds provided significantly less explanatory responses to causal questions than mid-SES parents. Moreover, children from mid-SES families were more willing to reengage the parents through offering their own explanations when they received unsatisfactory responses.

In a second study, we looked at differences in preschoolers' inferences about the credibility of informants based on the type of syntactic structure they used. One informant consistently used the passive voice when stating an argument, whereas the other informant consistently used the active voice. We asked who the child was willing to turn to when learning novel information (Corriveau et al. 2016). Although active voice is used most typically in daily conversations across all SES backgrounds, children from mid-SES families preferred to learn from an informant who had previously used the passive voice, whereas children from low-SES families preferred to learn from an informant who had previously used the active voice. We interpret these findings to indicate that in mid-SES families, young children view more complex syntactic structure is a marker of competence. By contrast, children from low-SES backgrounds view competence as the language they are more familiar with. Given that passive voice is a marker of academic language – the language of school (Snow & Uccelli 2009) – such differences in the inferences young children make about credibility may influence the types of individuals they turn to in learning situations.

When considering the BCD, it is important to consider how early learning experiences shape behaviors. Indeed, P&N note that early disparities can lead to larger eventual inequalities. Here, we argue that the larger inequalities are present from early in development. Specifically, the differences in the patterns of speech children are exposed to and how they use language to make decisions may be important factors to consider when thinking about the causes of the BCD.

The "appropriate" response to deprivation: Evolutionary and ethical dimensions

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Abstract: Pepper & Nettle use an evolutionary framework to argue that "temporal discounting" is an appropriate response to low socioeconomic status (SES), or deprivation. We suggest some conceptual refinements to their "appropriate-response" perspective, with the hope that it usefully informs future research on and public policy responses to the relationship between deprivation and temporal discounting.

Pepper & Nettle (P&N) synthesize a wide range of research linking low socioeconomic status (SES), or deprivation, with "temporal discounting"—a variety of present-oriented behaviors they group under the label of the "behavioral constellation of deprivation" (BCD). They argue that temporal discounting is "a contextually appropriate response" to deprivation. For scientific and philosophical reasons, we laud multiple aspects of the target article. Here, we offer several refinements that aim to help the "appropriate-response perspective" become more scientifically mature and of greater value to informing policy responses to poverty and inequality.

The target article attempts to use an evolutionary framework to explain the BCD as an environmentally contingent outcome. We approve of this overall approach. But the appropriate response perspective is not merely *an* evolutionary model; it is a *context-dependent* evolutionary model (see Lewis 2015; Tooby & Cosmides 1990a). Explicitly identifying it as such would allow future work in the area to make use of several important conceptual tools.

The first of these concepts is evolved information-processing design features (Lewis et al. 2017). A context-dependent model proposes that selection favored psychological mechanisms that take, as input, *specific* environmental cues linked to a specific survival- or reproduction-related problem (Lewis 2015; Lewis et al. 2017). "Extrinsic mortality risk," which the target article implicitly posits is the input into the context-dependent mechanism, does not meet this criterion. If evolved psychological mechanisms are responsible for the BCD, they would have evolved to be sensitive to specific cues. Homicide rates, food scarcity, rates of intergroup violence, and frequency of sexual assault might all be cues that the mechanisms take as input. The appropriate-response perspective could increase its explanatory power if it identified the specific environmental cues that the proposed mechanism processes as input.

A second key evolutionary concept that the appropriate-response perspective could fruitfully employ is by-products, or incidental effects (Kurzban et al. 2001; Lewis et al. 2017; Park 2007; Tooby & Cosmides 1990a; 1990b). As a consequence of their information-processing design, evolved psychological mechanisms can produce nonfunctional behaviors. Imagine an ancestral human in an environment containing cues to a low likelihood of future reward for delayed gratification. The context-dependent mechanism that took those cues as input could produce, as output, a greater valuation of immediate rewards. Tobacco and illicit drugs, substances whose human use is novel on an evolutionary timescale, may produce subjective rewards that exploit the mechanism's evolved design features. In this way, substance abuse issues linked to the BCD may reflect nonfunctional, by-product output of evolved context-dependent mechanisms.

The failure to distinguish between functional and nonfunctional outputs also results in clustering two fundamentally different phenomena under the rubric of "temporal discounting": impulsive behavior, which is inherently present-oriented, and plans of action, which are inherently future-oriented but can nonetheless intentionally discount future costs and benefits relative to those in the present (see Bratman 1987). It is much easier to see how planned temporal discounting might be functional in the context of deprivation than it is to make this case for impulsive behavior.

From an evolutionary perspective, the extent to which a behavior can be viewed as "appropriate" depends on whether it reflects the output of an evolved information-processing mechanism's *design*. If this is all that "appropriate" were meant to entail in the target article, then some of the impulsive elements of the BCD could undermine the proposed model. But although P&N do not attempt to explicitly connect the evolutionary underpinnings of the appropriate-response perspective to any broader ethical concepts, that connection is strongly suggested in their framing. "We emphasise the idea that the present-oriented behaviours of the constellation are a contextually appropriate response to structural and ecological factors rather than a pathology or a failure of willpower," they say (in the abstract). "By describing behaviours as 'contextually appropriate,' we wish to imply that they are understandable given the context in which people are operating" (sect. 2.1, para. 3).

We can ask three broadly different kinds of questions about the appropriateness of human action. First are questions about *prudence* or *instrumental rationality*. These questions take as fixed the goals that an actor has (or should have) and then ask whether the act is likely to serve those goals. Second are questions about *permissibility* and *obligation*. What prudence counsels is not always permissible; we may be obligated to do otherwise. Third are questions about *responsibility*. Sometimes we do things that are morally impermissible but have reasons or excuses that would make it inappropriate for others to blame us or punish us in response.

The evolutionary sense of "appropriateness" does not fit neatly into any of these three broad normative dimensions, although it is most closely aligned with the dimension of prudence or rationality (Maynard-Smith 1982). Noting the implications of P&N's appropriate-response perspective as a context-dependent model, however, may leave us in a better position to evaluate the BCD in terms of either permissibility or responsibility. For example, a fuller understanding of the origins of the BCD may steer us away from the view that it is morally impermissible for those living in conditions of deprivation to have children at a young age, out of wedlock, and while dependent on public assistance (Shelby 2016) or toward the view that we cannot justifiably blame or punish them for breaking the law as harshly as we would if they were better off (Lewis 2016). The ethical implications of the appropriate-response perspective could, in turn, help government agencies, legislatures, and judges evaluate the normative dimensions of their law and policy decisions – for example, in how they choose to structure social welfare benefits, and how they design and implement criminal sentencing and corrections systems.

Fleshing out the implications of the appropriate-response perspective as a context-dependent model may not only give us information about which policy interventions would most effectively serve a set list of social aims but also help us better understand which aims we ought to pursue. Unleashing its full potential will take further work in the behavioral sciences and in moral and political philosophy.

Both collection risk and waiting costs give rise to the behavioral constellation of deprivation

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Abstract: Pepper & Nettle explain the behavioral constellation of deprivation (BCD) in terms of differences in collection risk (i.e., the probability of collecting a reward after some delay) between high- and low-socioeconomic-status (SES) populations. We argue that a proper explanation should also include the costs of waiting per se, which are paid even when the benefits are guaranteed.

In an experimental study of impulsive decision making in starlings (Bateson et al. 2014), birds showing greater telomere attrition (an integrative marker of a poor biological state) were found to favor sooner-smaller rewards (one pellet of food in 1 second) over larger-later ones (five pellets in *x* seconds). An interpretation of these results based on differential mortality risks would be as follows: Starlings in a poorer biological state have a greater probability of dying before collecting delayed rewards and should therefore privilege short-term benefits. This interpretation would be undermined, however, by the fact that dying during a choice experiment that did not exceed a few minutes is an extremely unlikely event, even for birds in poor states.

In the target article, the authors provide an explanation for the behavioral constellation of deprivation (BCD) that is mainly based on variation in extrinsic mortality. However, as in the starling example above, average differences in mortality are unlikely to account for socioeconomic-status- (SES-) specific discounting rates when rewards are delayed over short periods (e.g., weeks, months, or even a few years). This point can be illustrated in humans with the study by Ramos et al. (2013) cited by Pepper & Nettle (P&N), which reports that slum-dwelling youth discounted future rewards more than university students. In this study, the delay used in the questionnaire did not exceed 75 days. Thus, the estimated cumulative probability of dying during the following 75 days would have had to be very high to justify the preference of sooner but smaller rewards. Such a situation, though, is not expected to hold across the majority of populations where the BCD is observed.

Hence, a gap seems to emerge once one tries to explain present orientation with differences in mortality whenever decision making is affected during short timescales. One way to address such cases in line with the target article would be to examine other factors underlying variation in collection risks (e.g., individuals' social capital, population level of cooperation). However, a complementary approach that does not follow from P&N's framework would rely on factors independent of collection risk.

We see at least one corresponding source of time discounting that ought to be considered: the cost of waiting for a reward per se (i.e., the cost paid by an individual even when the benefits are guaranteed). But why should there be a cost of waiting in the absence of a collection risk? After all, in a population at a demographic equilibrium, *x* fitness units now are strictly equivalent to *x* fitness units later. Delaying a reward is costly, however, if this reward can be *invested* into an individual's capital to increase his or her future ability to exploit the environment. In such a case, delaying the reward entails an opportunity cost corresponding to the additional fitness units that would have been gained with the increased level of capital during the delay. This principle can be illustrated with a thought experiment: Imagine a farmer who participates in an economic study in which he is offered a choice between receiving $1,000 now or $2,000 in a month. Because this particular farmer does not own any expensive agricultural equipment, he is only able to sow half of his fields simultaneously. However, $1,000 now would allow him to buy new equipment and exploit his whole farm. This would yield him an expected $2,500 increase in revenue by the end of the month. Hence, our farmer should prefer the smaller-sooner reward, even though the collection risk in our example could be close to zero and the larger reward is only delayed by a month. Instead, the fact that his current level of capital is associated with a particularly high opportunity cost in productivity determines his choice. Conversely, imagine a farmer who already owns sophisticated agricultural machines taking part in the same study. For him, $1,000 is not enough to upgrade his equipment. Rather, he is currently trying to save $15,000 by the end of the month to buy some extra land. In this case, waiting a month for the larger reward more greatly reduces the amount of money he has to save.

Such effects of the current amount of capital are likely to be pervasive. Indeed, in addition to increased productivity, as in the above example, an individual's capital can also yield a reduction in mortality risk (e.g., by buying a house in a town's safest neighborhood) or protect against capital depreciation (e.g., by investing in fire insurance). Crucially, the effect of capital should also directly map SES differences in temporal discounting. Although a formal treatment is needed here, we expect that when people have almost no capital, even the smallest amount of resources are likely to drastically improve their productivity or reduce their mortality. Therefore, they should generally favor sooner rewards even during shorter timescales. The more capital one already has, however, the larger the amount of resources that will be required to significantly increase it further, and the less steeply that future rewards should be discounted.

As an illustration, compare the cost one might pay for living in a small apartment rather than a house to the cost of living on the streets. In the first case, it might be noisy neighbors, the lack of a garden, or the inability to host many relatives for dinner. In the second case, however, it includes physical degradation from being exposed to climatic hazards, lack of hygiene or assaults from others, the inability to collect welfare support, social and economic exclusion in general, and so on. Therefore, someone living on the streets is likely to prefer any basic accommodation now over an individual house in 6 months, whereas someone living in a small flat might be willing to wait 6 months for an even better house.

In conclusion, ultimately, the interactions between waiting costs *per se* and collection risk will determine individuals' temporal discounting. Hence, by adding this novel class of factors to P&N's framework, we can expect to deepen our understanding of the BCD.

Socioeconomic status, unpredictability, and different perceptions of the same risk

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Abstract: In this commentary, we address three questions: (1) How might outcomes be affected by the *variation* in the level of deprivation, rather than the average level of deprivation? (2) Could there be differences in the subjective *perception* of the same risk as either intrinsic or extrinsic, depending on people's socioeconomic status (SES)? (3) What other psychological mechanisms might play a role in influencing the psychology and behavior of people from deprived backgrounds?

We applaud the effort by Pepper & Nettle (P&N) to apply evolutionary principles toward the understanding of behaviors associated with lower socioeconomic status (SES). It is encouraging to see that the seemingly short-sighted behaviors by people from deprived backgrounds are conceptualized as contextually appropriate responses as opposed to impaired responses. We also think that highlighting the role of personal control as a psychological factor underlying the behavioral constellation of deprivation (BCD) is important and consistent with past research (Lachman & Weaver 1998; Mittal & Griskevicius 2014).

In this commentary, we address three questions: (1) How might outcomes be affected by the *variation* in the level of deprivation, rather than the average level of deprivation? (2) Could there be differences in the subjective *perception* of the same risk as either intrinsic or extrinsic, depending on people's SES? (3) What other psychological mechanisms might play a role in influencing the psychology and behavior of people from deprived backgrounds?

Question 1. The target article makes a case for how deprivation might be related to sense of control and to outcomes associated with temporal discounting. The idea is that people with fewer resources perceive diminished personal control over various aspects of their lives and, consequently, engage in more present-oriented behaviors. This idea is well supported empirically (Bosma et al. 1999; Mittal & Griskevicius 2014), yet there may be more to the story. From a life history perspective, it is not only the absolute (or average) level of deprivation but also the variation or fluctuation around this absolute level that should play key roles in affecting sense of control and temporal discounting.

According to the life history theory (Ellis et al. 2009), challenging environmental conditions, such as those of people living in deprivation, can differ in the extent to which they are harsh and/or unpredictable. "Harshness" refers to the rates of morbidity-mortality in the local environment and tends to be linearly associated with SES. "Unpredictability" refers to the fluctuation in harshness in space or over time. Recent studies that have measured these two variables have found that harshness and unpredictability can have unique effects (Mittal et al. 2015; Simpson et al. 2012; Szepsenwol et al. 2015). For example, early-life unpredictability but not harshness is associated with sexual and risky behavior later in life (Belsky et al. 2012; Simpson et al. 2012). Harshness and unpredictability might have distinct effects, because the adaptive methods to deal with a consistently harsh environment are different from the methods to deal with a rapidly changing and inconsistent environment (Ellis et al. 2009).

This suggests that the consequences of living in a harsh, low-SES environment might be different, depending on whether it is predictable or unpredictable. For example, it is possible that the observed lack of personal control among those from deprived backgrounds is due to the unpredictability they face in their daily lives rather than to the harshness of their environments. Therefore, it might be worthwhile to think of deprived environments as being multidimensional, with harshness and unpredictability having different and unique effects.

Question 2. The target article presents extrinsic and intrinsic risks as inherent features of the SES environment, whereby some risks are extrinsic and some are intrinsic. It is proposed that *perception* of greater extrinsic mortality risk among low-SES people is a contributing factor for their perceived lack of control over life outcomes. Because low-SES environments are more dangerous and characterized by greater mortality risks (Adler et al. 1994; Evans 2004), it is understandable that people living in such environments perceive their own mortality as being extrinsic (Pepper & Nettle 2014b).

However, there might be differences in the perception of the same risk, depending on people's SES. Low-SES individuals, for example, might perceive a risk as being more extrinsic even though they may not be at any more risk than their high-SES counterparts. Recent research suggests that even for risks that are equally distributed across the SES spectrum, people from deprived backgrounds are more likely to perceive them as being more extrinsic (Mittal & Griskevicius 2016). This suggests that even when the risks are *objectively* the same for a high- and for a low-SES individual, the low-SES individual might *subjectively* perceive the risk to be more intrinsic than his higher-SES counterpart does. This tendency might further perpetuate the feeling among low-SES individuals that things around them are uncontrollable, even though they may actually be controllable.

Question 3. Sense of control plays a key mediating role in how deprivation influences temporal discounting, but other psychological mediators might also play a role. For instance, levels of optimism and pessimism regarding the future also vary, depending on people's SES, and may affect temporal discounting (Bosma et al. 1999; Heinonen et al. 2006; Mittal & Griskevicius 2016), with lower SES during childhood being associated with lower levels of optimism and greater levels of pessimism in adulthood. Although sense of control and optimism are positively correlated (Klein & Helweg-Larsen 2002), they are distinct. "Sense of control" refers to people's perceived ability to influence future outcomes, whereas "optimism" refers to people's tendency to perceive their own futures as more positive than those of their peers (Scheier & Carver 1985). This distinction suggests that optimism may influence outcomes that are beyond people's control and may therefore act as an independent mediator.

Taken together, just as there is a constellation of behavioral outcomes associated with deprivation, there may be a constellation of psychological, mediating mechanisms driving those outcomes, including sense of control and optimism/pessimism.

The target article by P&N contributes a great deal to our understanding of people living in deprivation and the factors that lead them to make decisions that hurt them. We echo the sentiment that, despite well-established SES inequalities in various life outcomes, the underlying processes are poorly understood. Our commentary offers three questions with the goal of obtaining a more complete and nuanced understanding of why and how SES differences result in health and financial disparities.

Relative state, social comparison reactions, and the behavioral constellation of deprivation

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Abstract: Pepper & Nettle compellingly synthesize evidence indicating that temporal discounting is a functional, adaptive response to deprivation. In this commentary, we underscore the importance of the psychology of relative state, which is an index of relative competitive (dis)advantage. We then highlight two proximate emotional social comparison reactions linked with relative state – personal relative deprivation and envy – that may play an important role in the deprivation-discounting link.

Pepper & Nettle elegantly elucidate how deprivation reduces personal control through individuals' (in)ability to "purchase" reduced hazard exposure. Here, we emphasize the importance of relative (versus absolute) deprivation in the etiology of the behavioral constellation of deprivation (BCD). We argue that decision making is necessarily sensitive to relative state, and that emotional social comparison reactions to comparative disadvantage – namely, personal relative deprivation and envy – may be key proximate mechanisms that serve as "barometers" of individuals' relative (dis)advantage, in turn motivating behaviors in the BCD.

Like all other organisms, humans do not make explicit and conscious biological fitness calculations to guide behavior. Rather, judgment and decision making (and cognition more generally) likely involve the use of a toolbox of ecologically rational implicit heuristics (Todd & Gigerenzer 2012). These "fast and frugal" heuristics are in large part motivated by the acquisition of "proxies of fitness": mates, resources, and social status that increase the probability of individuals surviving and producing viable offspring (i.e., enhancing inclusive fitness; Mishra 2014).

Mishra et al.'s (2017) relative state model proposes that decision makers are particularly sensitive to cues of relative (dis)advantage (i.e., decision makers are sensitive to their relative states) arising from embodied and situational factors. In turn, relative state informs decision making around proxies of fitness. The logic of the relative state model is simple. Fitness is necessarily a product of reproductive outcomes relative to others (Hamilton 1964). Individuals who fail to notice (or do not counteract) disadvantaged access to proxies of fitness are less likely to have their genes represented in future generations (Garay & Móri 2011). Consequently, natural selection likely gave rise to cognitive and emotional mechanisms calibrated to be sensitive to relative state.

Feelings of personal relative deprivation and envy may serve as proximate "barometer" measures of one's own relative state, consequently guiding behavior (including those in the BCD). Personal relative deprivation describes feelings of angry resentment in reaction to perceptions of unfair disadvantage (Smith et al. 2012). Recent empirical work has linked personal relative deprivation with several outcomes implicated in the BCD. For example, personal relative deprivation has been linked with such present-oriented behaviors as gambling, delay discounting, antisocial risk taking, criminality, and reduced cooperation (e.g., Callan et al. 2011; Mishra & Novakowski 2016). Personal relative deprivation has also been associated with poorer mental and physical health, even after controlling for indices of absolute socioeconomic status (SES; e.g., Callan et al. 2015; Mishra & Carleton 2015).

Envy is another proximate emotional consequence of relative (dis)advantage. "Envy" is defined as a feeling of inferiority, hostility, and resentment when another person or group has a desired advantage (Smith & Kim 2007). Malicious envy and benign envy are different ways that people react to disadvantages. "Malicious envy" encompasses feelings of injustice, the motivation to harm the envied individual, and perceptions of low control. "Benign envy" encompasses the motivation to strive upward and to exercise greater perceived control over future outcomes (van de Ven et al. 2009). Because malicious envy and the BCD stem in part from low perceived control, malicious envy may represent an important proximate emotional mechanism involved in the BCD. In contrast, the existence of benign envy suggests the presence of an alternative to the BCD among the disadvantaged.

Perceived disadvantage may be initially met with a reaction of benign envy, with individuals feeling control over their situations and feeling able and motivated to strive upward (thus not exhibiting the deleterious behaviors implicated in the BCD). However, if individuals' efforts are routinely unsuccessful (as they often are in environments with low upward mobility), they may lose a sense of control over their situations. In turn, individuals may see their relative disadvantages as undeserved ("I've worked hard and nothing has come of it. It's wrong that other people have it so easy!") and come to experience personal relative deprivation and/or malicious envy, eventually resulting in behaviors and outcomes characterized by the BCD.

The psychology of relative state has important bearing on such contemporary societal issues as inequality. Victimization by inequality, like extrinsic mortality risk, decreases an individual's control over his or her situation and impedes the ability to capitalize on deferred rewards. Given low rates of social mobility in human populations (Clark 2014), inequality tends to be experienced persistently across the life span. Those who are born disadvantaged (regardless of whether this disadvantage is a product of embodied or situational influences) likely learn through experience and observation that they have little control over their relative states. Consequently, victims of inequality allocate their limited time, resources, and energy to immediate, often riskier, strategies (reviewed in Daly 2016).

Importantly, relative state is relevant even among individuals who are not in situations of absolute deprivation. Consider the example of the workplace. Employees are stratified by income, occupational status, benefits, and reputation. Although many employees may be comfortably insulated from extrinsic mortality threats, perceived disadvantage in the workplace may motivate such present-oriented behaviors as reduced cooperation, embezzlement, and absenteeism. Objectively privileged individuals may still experience negative social comparison reactions and act in consequence (e.g., "white-collar" crime; Agnew et al. 2009).

Taken together, the findings reviewed above (and in the target manuscript) suggest that absolute deprivation (e.g., poverty), and relative deprivation (e.g., inequality) are importantly associated with the BCD. Both are important inputs into the psychology of relative state. We further suggest that proximate social comparison reactions (personal relative deprivation and envy) are emotional "barometer" measures of one's own relative state that partly motivate the BCD. Future research should examine whether perceived inequality and perceptions of low control over social mobility predict (a) greater feelings of malicious envy and personal relative deprivation and (b) lesser feelings of benign envy, and whether these reactions can explain additional variance in the BCD beyond early mortality exposure, perceived control over mortality risks, and other indices of absolute deprivation.

When does deprivation motivate future-oriented thinking? The case of climate change

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Abstract: Pepper & Nettle overstate cross-domain evidence of present-oriented thinking among lower-socioeconomic-status (SES) groups and overlook key social and contextual drivers of temporal decision making. We consider psychological research on climate change – a quintessential intertemporal problem that implicates inequities and extrinsic mortality risk – documenting more future-oriented thinking among low- compared to high-SES groups.

Pepper & Nettle (P&N) propose that present-oriented behaviors associated with deprivation may often be "contextually appropriate" responses to structural and ecological factors. We appreciate P&N's emphasis on context as a key determinant of group differences in temporal decision making but argue that a more *socially*

contextualized perspective on deprivation is needed. In particular, theoretical models of deprivation should consider two factors that can promote more *future-oriented* thinking among members of economically disadvantaged relative to advantaged groups: (a) salient group-based inequities that inform differential assessments of risks among lower- and higher-socioeconomic-status (SES) groups; and (b) the presence of cooperative norms that promote trust between members of disadvantaged and advantaged groups.

Specifically, we note that in contexts in which SES disadvantaged groups incur greater risks, where these risks are understood, and where there are long-term costs to inaction, we find evidence of *more* future-oriented behavior and *less* temporal discounting among low- relative to high-SES groups. We illustrate this with findings from psychological research on climate change – a quintessential intertemporal decision-making context that implicates social inequities (e.g., differential impacts on the wealthy and poor) and extrinsic mortality risk.

Climate change offers a unique context to understand how group-based inequities can shape temporal decision making, with the potential to inform our understanding of how different segments of the public understand extrinsic risks more generally, such as those associated with violence and infectious disease. Economic projections suggest that unmitigated climate change will disproportionately affect the world's poor (Burke et al. 2015). Moreover, awareness of inequities between groups can exacerbate hostility within and between nations and undermine the ability of communities to adapt to climate impacts (Agyeman et al. 2003).

Public opinion research suggests that low-SES groups are more concerned about climate change than higher-SES groups (Akerlof et al. 2016; Bohr 2014; Macias 2016; McCright & Dunlap 2011; Semenza et al. 2008; Stokes et al. 2015; Xiao & McCright 2012; for a review, see Pearson et al. 2017) and show more support for mitigation policies, even when those policies incur short-term costs (e.g., new or increased taxes; Leiserowitz & Akerlof 2010). For instance, Stokes et al. (2015) report that Americans who make less than $50,000 per year were more likely to believe that climate change is a very serious problem and were more concerned that it would harm them personally than those making more than $50,000 per year (for similar cross-national evidence of greater concern in poorer versus wealthier nations, see Sandvik 2008).

Similar effects have been observed in members of other disadvantaged groups. For instance, blacks and Latinos in the United States express higher levels of environmental concern than whites and show higher levels of support for national and international climate and energy policies than whites, including proportionally higher support for regulating carbon emissions, increasing taxes to improve household-energy efficiency, and increasing taxes on gasoline (Leiserowitz & Akerlof 2010; see also Dietz et al. 2007; Leiserowitz 2006; Macias 2016; Pearson et al. 2017).

P&N argue that it is not necessarily such factors as income or education that lead to differences in temporal discounting but "the experience of various hardships, or deprivations, that are often associated with being of lower SES" (sect. 2, para. 1). We agree and suggest that when linked to group disparities (i.e., collective disadvantage), awareness of relative deprivation may prompt more *future-oriented* thinking among members of disadvantaged groups to reduce perceived inequities. Feelings of inequity—which coincide with lower SES—can enhance attention to immediate rewards that are perceived to redress inequity over time (Callan et al. 2008). Moreover, when feelings of inequity are reduced, lower-SES individuals typically show *higher* levels of prosociality in public goods games (a future-oriented strategy) than those of higher SES (Callan et al. 2016).

In contrast, members of advantaged groups may show evidence of temporal discounting to maintain their relative advantages. For instance, individuals from higher-SES groups who are more likely to perceive existing hierarchies as just and fair (e.g., conservative white males; McCright & Dunlap 2011) are also less supportive of environmental regulations, which may be perceived as threatening established social, economic, and political systems (Feygina et al. 2010; see also Hennes et al. 2016).

A greater appreciation of the social context in which decision making occurs can also inform our understanding of social motivations that may underlie temporal discounting. In particular, temporal discounting, in some cases, may be motivated by distrust of higher-SES groups rather than by the direct effects of deprivation. Indeed, within the United States, class conflict now ranks ahead of other leading sources of perceived conflict (e.g., between immigrants and native-born citizens), with more than two-thirds of Americans endorsing the view that there are "strong" or "very strong" conflicts between the rich and the poor (Morin 2012). Studies suggest that economic inequality can undermine trust and cooperation by attenuating optimism and reducing a sense of shared fate across economic strata (Uslaner & Brown 2005). Group disadvantage can also evoke feelings of collective anger, which can motivate people from disadvantaged groups to take collective action on behalf of their groups (van Zomeren et al. 2008). The *social* context of deprivation may, thus, motivate efforts to enhance one's relative group position in the near term to reduce social inequities in the long term.

Research on public goods games suggests that the presence of strong democratic norms, such as voting procedures that promote trust between group members, can inspire long-term cooperation across groups (Hauser et al. 2014). Real-world data are consistent with the notion that sustained future-oriented decision making is highly contingent on group norms. For example, countries with stronger democratic institutions also have more sustainable-energy policies (see Hauser et al. 2014). In short, we argue that deprivation does not uniformly lead to higher temporal discounting among those with lower SES and, more importantly, that taking note of the social context in which decision making occurs is key to developing a context-sensitive theory of deprivation.

Cultural consonance, deprivation, and psychological responses for niche construction

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Abstract: Cultural consonance is a measure of culturally encoded goals relevant to psychological, behavioral, and health responses to deprivation. Similar to extrinsic mortality, low cultural consonance and an associated inability to predict adaptive outcomes may activate impulsivity, delay discounting, and reward seeking. Low cultural consonance could promote "fast life history" in low-quality environments and motivate cultural niche construction for local adaptation.

Pepper & Nettle (P&N) offer a welcomed synthesis improving our understanding of responses to poverty in a life-history framework. I propose two related extensions: (1) accuracy of cultural encoded expectations, similar to extrinsic morbidity-mortality, may affect life history and the behavioral constellation of deprivation (BCD); and (2) in addition to life-history effects, impulsivity may promote niche construction (e.g., Fuentes 2016; Kendal et al. 2011; Stotz 2010) in response to extrinsic risks.

Predicting allocation of effort in life history assumes that people can perceive culturally relevant "currencies" for success in context (Irons 1998). Theoretically, people pursue salient resources in cultural models of production, because they expect their efforts to

result in locally defined success, ultimately resulting in fitness. Cultural success can be measured as the production of relevant resources that meet basic needs (e.g., food security) and improve well-being. Key resources can be measured in many cases as "wealth" – income and assets (Stulp et al. 2016) – although there are multiple possibilities for the differential value of "wealth types" (e.g., Mattison 2011) and for less-monetized measures of cultural success (Borgerhoff Mulder et al. 2009; Macfarlan et al. 2012; 2014). Measuring perception of relevant resources is a key empirical advancement for cross-cultural comparison that is relevant to human life history and BCD.

Cultural consensus analysis assesses adaptively relevant, shared perception (Romney et al. 1987; Weller 2007). Through environmental feedback, a group arrives at shared mental models of expected environments from common experience in "patterned practice" (Roepstorff et al. 2010). In a relatively stable environment, most members of a group should agree on ways of making a living, and this agreement has been measured as "consensus" for livelihood schemata (Romney et al. 1987; Weller 2007).

Cultural consonance is the extent to which culturally encoded environmental expectations (consensus models) match individual experiences (e.g., Dressler 2012; Dressler et al. 2005; 2017). When shared goals match individual experiences (i.e., predicting events and outcomes), then one has high cultural consonance. Low cultural consonance – poor fit between shared goals and individual experience – can be framed as perceived deprivation and error in predictive perception, suggesting benefits of delay discounting, impulsive behavior, and reward seeking for life history and niche construction. Recent research indicates that low cultural consonance is associated with a suite of outcomes emphasized in life-history theory regarding health behaviors and "internal prediction." Low cultural consonance measured across gradients of environmental quality has been associated with low subjective well-being (Reyes-García et al. 2010), depression (Dressler et al. 2007a; 2007b; 2016), hypertension (Dressler et al. 2005), substance use (Dressler et al. 2004; Reyes-García et al. 2010), inflammatory immune response (Dressler et al. 2016; 2017), and so forth. Finally, cultural consonance has been shown to mediate the effects of socioeconomic status (SES), genetics, and early life adversity on depression; this mediation is especially pronounced in lower-SES communities (Dressler et al. 2016). These chronic health effects indicate "internal prediction" (Rickard et al. 2014) and somatic feedback for life-history strategies with less planning, early reproduction, and so forth, as described in P&N's BCD model.

Cultural consonance can be framed as Bayesian processing, whereby cultural representations supply prior probabilities for navigating specific environments. Fit between mental models and environmental conditions is assessed by "predictive processing" based on feedback between people and their environments. Perception involves a set of "top-down" models or expectations fit to "bottom-up" data coming from the environment to inform action in bidirectional processes (Clark 2013). A person's internal state is a kind of conversation between mental models and sensory information interacting to make sense of the world. Repeated interactions with social, economic, and political aspects of an environment results in "patterned practice" shaping attention and expectations (Roepstorff et al. 2010; Strauss & Quinn 1997). In this sense, culture is a set of representations of the world that provides "model goal states" (Barkow 1989) and locally relevant prior probabilities for achieving a goal (Clark 2013, 6). Hence, people deploy a probabilistic or "predictive" mind in planning action (Toussaint 2009). When cultural expectations conflict with incoming information, then a bidirectional mind may seek new input to reorganize perception to fit the changing environment. This line of reasoning suggests that low cultural consonance may be a highly salient measure of "surprise" or uncertainty relevant to life history, BCD, and niche construction.

Cognitive noise interfering with inferential processes has resulted in impulsive immediate action and significantly discounted delayed rewards in experiments (Deck & Jahedi 2015; Hinson et al. 2003; Koffarnus et al. 2013), although results are sometimes inconsistent (Koffarnus et al. 2013). Cognitive load impedes useful probabilistic inference for the task at hand. Ecologically mismatched cultural models, common in poorer communities with substantial uncertainty, may be one source of cognitive noise. It is possible that aspects of impulsivity function to ignore representations (plans) that fail to predict incoming signals and simultaneously increase sensory input to arrive at new, better-fitting representations. Behavioral-activation and reward-seeking components of impulsivity (Carver & White 1994; Morean et al. 2014) could be particularly useful for niche construction.

When cultural expectations fail, then a Bayesian mind may activate impulsive action to generate new input to reorganize perception for a new niche. Response to "surprise" (including low consonance) can be as simple as eye movements in search of information useful for perceptual models (Friston et al. 2012). In other cases, surprise might motivate a person to change position in the environment to better match perceptual schemata. People may also probe the environment for new information to construct representations that better match their experiences.

A small body of work indicates that impulsive behavior may be differentially activated in response to hazards in stable versus unstable environments, suggesting different niche construction motivations. Similar to findings from delay-discounting experiments (Griskevicius et al. 2011b), an observational study indicated that Ethiopian farmers pursuing high-risk nontraditional maize production showed a significant increase in impulsivity in response to household morbidity-mortality and negative income shocks compared with farmers from relatively stable environments who were cultivating traditional drought-resistant crops (Quinlan et al. 2016). Cultural consonance and niche construction processes may help explain these differential responses to environmental hazards consistent with BCD models.

Loss of control is not necessary to induce behavioral consequences of deprivation: The case of religious fasting during Ramadan

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Abstract: Pepper & Nettle argue that the more present-oriented behavior associated with a low socioeconomic status is an adaptive response to having relatively little control over the future. However, a study of fasters during Ramadan shows that self-imposed deprivation, which carries no implications regarding the ability to realize deferred rewards, is associated with loss and risk aversion.

Poverty and associated resource scarcity have a profound negative influence on human decision making, leading to heightened risk aversion, loss aversion, and temporal discounting (Callan et al. 2011; Yesuf & Bluffstone 2009). Pepper & Nettle (P&N) describe these consequences of deprivation as a behavioral constellation that they argue is an adaptive response to a relative lack of control over future events. Their target article offers an elegant "realist" perspective: The poor may be less patient and more impulsive, because for them, waiting does not promise the same outcomes as it does for the nonpoor, and lower perceived or actual control over future events leads to higher discounting of the future.

P&N's theoretical perspective differs from other explanations of the effects of scarcity on economic decision making. Alternative theories attribute the behavioral constellation of deprivation (BCD) directly to physiological and psychological effects of scarcity. For example, Haushofer and Fehr (2014) review evidence suggesting that present-oriented choices are partly due to negative affect and increased physiological stress associated with scarcity. Other research shows that scarcity leads to attentional focus on present needs, to the detriment of longer-term tasks (Bari & Robbins 2013; Shah et al. 2012) and is associated with impairment of the basic cognitive abilities needed to make good economic choices (Mani et al. 2013). Direct cognitive effects of scarcity are particularly damaging to P&N's account; it is difficult to understand how broad cognitive impairment is adaptive. However, our commentary focuses on a different aspect of P&N's account. P&N's theory suggests specific empirical hypotheses. If behavioral consequences of deprivation are adaptive responses to uncertainty, they should be limited to instances when deprivation is imposed by context and when deprivation implies an uncertain or short future.

Religiously motivated self-deprivation, which is a significant feature of human culture, offers a good test case of P&N's theory. Many religious traditions ask followers to undergo periodic instances of voluntary deprivation or abstinence, possibly to exercise willpower or as a costly signal of allegiance to gods and co-religionists (Atran & Ginges 2012). Cross-cultural prevalence of such practices suggests that they might have been favored by cultural selection for the benefits they confer to the expansion of human cooperation (Carter & McCullough 2010; Ginges et al. 2009; Henrich et al. 2010; Norenzayan et al. 2009). P&N suggest that exogenously caused deprivation creates uncertainty about future prospects, making it adaptive to discount the future in decision making and leading people to more heavily weigh immediate and certain prospects over risky and longer-term ones. If their theory is correct and the BCD is an adaptive response to a lack of control over future prospects, it ought to be absent in cases of religiously motivated self-deprivation, such as fasting.

For more than a billion Muslims around the world, the month of Ramadan is marked by a stringent form of self-induced scarcity: fasting by refraining from eating and drinking between sunrise and sunset. We were interested in whether religiously motivated deprivation might have the same effect as involuntary deprivation on economic decision making. Religiously motivated deprivation is generally under an individual's control. The pressure of social norms notwithstanding, religious norms require people to break their fast or not fast at all if health risks are high. Fasters therefore have control over whether and how long they will continue their self-induced food deprivation. More importantly, fasting has no implications regarding future prospects, neither implying a shorter life span nor a more uncertain material future. If P&N's account is correct, this suggests that religiously motivated scarcity should not be detrimental to decision making. Yet if scarcity directly impairs cognition, those fasting should make poorer economic decisions.

We recruited a sample of 183 self-identified Muslims to participate in an online study during the last 10 days of Ramadan in 2016 (June 26–July 4). In this sample, 86 participants reported that they were fasting, and 97 stated that they were not fasting. Fasters scored higher on intrinsic religiosity, and our analyses controlled for this measure along with socioeconomic status (for details, see Salari Rad & Ginges 2017). Participants completed two economic tasks. In a risk-aversion task, participants had to decide between receiving a sum of money for sure or having a 50% chance to win $10,000 (Guiso et al. 2013). The amounts accepted to forgo the chance of winning the larger sum are indicators of risk aversion. In a loss-aversion task, participants were presented with six gambles with decreasing expected values and asked whether they would participate in each gamble (Gaechter et al. 2007). We found that fasters were more risk and loss averse, suggesting that self-induced deprivation has similar effects to involuntary deprivation (Fig. 1).

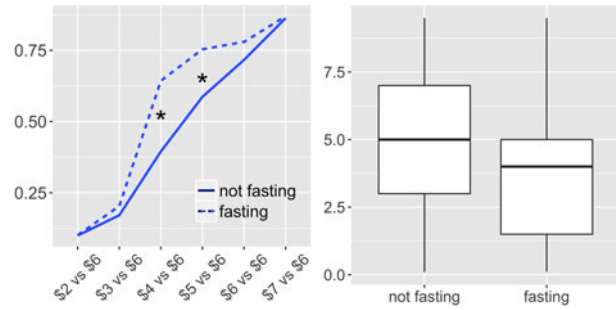

Figure 1 (Rad & Ginges). Fasters were more loss and risk averse than nonfasters. The left panel shows the proportion of participants who rejected each gamble shown on the horizontal axis. When choices were difficult (losing $4 vs. winning $6 and losing $5 vs. winning $6), fasters showed greater loss aversion by rejecting the gamble even though accepting it was the better choice. The right panel shows the average amounts (in thousands) that participants accepted to forgo a 50% chance of winning $10,000. Fasters showed greater risk aversion by requiring less money to forgo the gamble.

Our results suggest that P&N do not offer the best account for the effects of scarcity on economic decision making. Fasting respondents in our study knew that the fast would end at sunset and that they could end it at any time if they wished, yet they still made risk- and loss-averse decisions. This behavior suggests that perceived or actual control over future outcomes is not a necessary feature of the BCD.

Intergenerational capital flows are central to fitness dynamics and adaptive evolution in humans

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Abstract: Human fitness dynamics are uniquely and profoundly governed by the flow of capital to subsequent generations. Low socioeconomic status individuals may possess limited capacity to direct capital to descendants and may respond to such constraints adaptively or maladaptively. Mitigation of capital constraints may provide practicable routes to alleviation of the behavioural constellation of deprivation.

In providing an adaptive rationale for socioeconomic (SES) patterning of unhealthy behaviours, Pepper & Nettle (P&N) have made valuable steps towards a more enlightened approach to understanding the role of "lifestyle factors" in contributing to health inequalities. In explaining human behavioural responses to social deprivation, P&N focus most of their attention on one specific factor in shaping the evolution of adaptive behavioural responses: extrinsic mortality risk. However, they do explicitly state that their synthesis in principle should be generalizable to other factors that may shape evolutionary fitness. I take this opportunity to build on the sections of their work that go beyond the role of extrinsic mortality, focusing on the unique features of human fitness dynamics.

In the case of most animals, the question of why an organism might be selected to maintain investment in its body at a given age is a no-brainer: Stay alive and you may get to breed again

and thereby pass on your genes. However, from such straightforward beginnings, the game of maximising long-term genetic representation is altered in humans – extensively, profoundly, and multidimensionally. The combination of advanced cognitive skills, a high degree of sociality, and cumulative culture means that the way that humans relate to their physical environments and to each other is unique. The resulting possibility of accumulation of different forms of "capital" creates new channels through which individuals can differ in their fitness prospects from one another. Schema for conceptualising these diverse capital forms are too numerous to discuss at length here (e.g., Bourdieu 1986; Kaplan et al. 2003). They may include physical possessions, land entitlement, technical skills, cognitive capacity, emotional resilience, social esteem, social contacts, and financial resources. Some of these forms of capital do exist in tangible physical form, but others are more abstract and are not subject to the same constraining laws of trade-offs and depreciation as somatic capital.

Inheritance of capital in these forms down the generations will have been central to human fitness dynamics, a matter that P&N touch upon in their mentions of educational investment. Those who are able to use their own capital to increase the capital held by their descendants will cause them to thrive, buffer them against environmental adversity, and ultimately enable them to multiply. In fact, selection for staying alive beyond the fifth decade (an ancestral feature of humans) can only have been entirely driven by intergenerational capital transfers from females, and this is probably mostly true for males also (Vinicius et al. 2014). Therefore, adaptive responses to adversity will be to a significant extent driven by the fact that the threat of reduced healthy years left to live not only decreases reproductive opportunities (Fig. 1, pathway i) but also decreases the opportunities to transmit capital down the generations to existing descendants (Fig. 1, pathway ii).

Explicit acknowledgment of the separation of these pathways is pregnant with implication. A bigger question rears its head: Just how large a role does the reduced opportunity for intergenerational resource transfer play in shaping adaptive responses to adversity? (Fig. 1, **pathway iii**). P&N do allude to the role that social and financial capital limitation may play, but they do not consider the likely importance of such pathways relative to those that limit healthy life spans. In short, apparent evidence for adaptation to **pathway i** may also be evidence for adaptation to **pathway iii** as well as **pathway ii**.

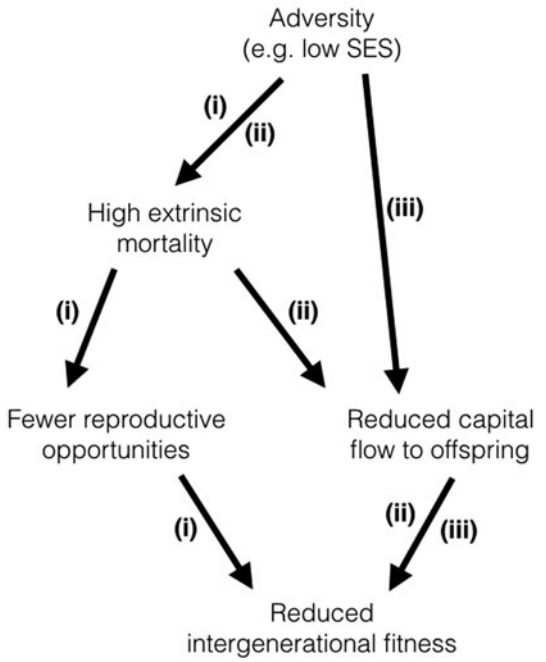

Figure 1 (Rickard). Schematic showing three pathways through which adversity, such as low socioeconomic status, may reduce evolutionary fitness and to which behavioural adaptation may evolve.

A high degree of complexity in human fitness dynamics is engendered by the diverse forms of capital involved in these additional pathways and the various ways in which they can interact with one another. There are numerous opportunities for synergies and positive feedback processes operating within and between generations. Skills may be used to advance social positions. Possessions may be traded for favours. Parents may purchase education for their children. This complexity is likely to have been reflected in human adaptive evolution, specifically in cognitive processes that enable humans to adapt to the opportunities and constraints concomitant with possessing high or low levels of capital in the various currencies. Low SES individuals may lack capital in forms that high SES individuals take for granted (e.g., Mani et al. 2013) and behave in ways that are, once all is said and done, tractable and perhaps rational. This is likely a rich area for future research.

Caution must be applied when applying an adaptive framework to understanding the behavioural response to deprivation. For most of our evolutionary history, constraints on capital accumulation limited the extent to which individuals and lineages could deviate from one another in terms of status. The complexity of socially structured societies that have arisen since the dawn of agriculture has multiplied further still the ways by which individuals with means can advantage their descendants, leading to a dramatic increase in inequality (Borgerhoff Mulder et al. 2009). Adaptive evolution is unlikely to have had a chance to catch up with this specific development. Therefore, we must be alive to the prospect that individuals sometimes respond to inequality maladaptively or that adaptations may be achieved through general, rather than specific, cognitive processes.

Why does this matter? There are real implications of taking a broader approach to understanding human fitness dynamics that take the capacity for intergenerational resource transfer, in addition to intrinsic somatic health, to be central to adaptive behavioural processes. It is clear that many aspects of an individual's intrinsic capacity for healthy life are determined by early life processes beyond his or her control. Indeed, the capacity of policy makers to make a difference in the face of such tangible inequality, embodied as well as embedded, may be limited. What we might well call their capacity for "well-being," on the other hand, is influenced by myriad different factors rooted in the social world and as a result may offer clues for routes of constructive intervention, with consequences for subsequent generations.

Stuff goes wrong, so act now

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Abstract: Pepper & Nettle make an ambitious and compelling attempt to isolate a common cause of what they call the behavioral constellation of deprivation. We agree with the authors that limited control can indeed help explain part of the difference in observed present-oriented behavior between the poor and the rich. However, we suggest that mortality risk is not the primary mechanism leading to this apparent impatience.

Pepper & Nettle (P&N) make an ambitious and compelling attempt to isolate a common cause of a large set of related behaviors that seem to differ across rungs on the socioeconomic ladder. The focus of this paper is a set of behaviors that are related through their temporal aspect of "front-loading" consumption and gratification to the present despite potential negative consequences in the future. The common cause is hypothesized to be limited control associated with lower socioeconomic status (SES). We agree with the authors' view that limited control, as well as the *perception* of limited control, can indeed help explain part of the difference in observed present-oriented behavior between the poor and the rich. However, we disagree with the use of mortality risk as the primary illustrative example of a mechanism leading to this apparent impatience: In our view, several other mechanisms are more plausible.

Intrinsic mortality appears like a reasonable mechanism behind present-oriented behavior observed in low-SES individuals: If mortality risk makes the future uncertain, it makes sense to consume now. When we combine data on temporal discounting from 53 different countries recently reported by Wang et al. (2016) with country-specific mortality rates from the World Health Organization (WHO), we do indeed find a negative correlation between mortality and discount factors ($r = -0.36$, $p = 0.0096$), with lower discount factors being associated with more discounting (see also Heimer et al. 2017 for further evidence). However, observed rates of temporal discounting are much too high to be accounted for by mortality risk, even when we generously ascribe *all* mortality risk to extrinsic causes. Specifically, people discount 46% over one year in Wang et al. (2016) – that is, they are indifferent between receiving a payment of $\$x$ one year from today and $\$x * 0.46$ today, which translates into a required interest rate of more than 116%. However, average mortality risk over one year in the countries in this dataset is only 0.148%;[1] thus, if the risk of dying before a future payment were realized were the only factor influencing discounting, people would be indifferent between receiving $\$x$ in one year and $\$x * 1/(1 + 0.00148) = \$x * 0.999$ today. Mortality risk can therefore only account for 0.13% of the observed discounting. To produce discounting on the order of magnitude observed in the data, people would have to mis-estimate the prevailing mortality risk by a factor of 769. This mismatch would be even more egregious if we restricted the mortality risk to extrinsic (i.e., uncontrollable) causes, as argued by P&N, and would remain significant even when using the lower discount rates typically estimated with the convex time budget method (Andreoni & Sprenger 2012). Thus, even if mortality rates partially explain the behavioral constellation of deprivation, it seems unlikely that it is the most important explanatory factor.

However, in our view, the authors' main hypothesis is correct; in the following, we illustrate three examples for the kind of uncertainty that could produce differences in observed discount rates at different rungs of the SES ladder.

First, poor individuals often face unpredictable income streams and liquidity constraints. The magnitude of these fluctuations can be substantial, and they mechanically create a preference for immediate payments over delayed payments. An example comes from Carvalho et al. (2016), who study time preferences of poor individuals before and after payday, finding that these people are more present-biased before payday for monetary but not effort outcomes. These findings suggest that liquidity constraints and income uncertainty in resource-poor contexts can lead to a focus on the present.

A completely different illustration of the environmental risks faced by individuals in low-income contexts comes from attrition rates in household surveys, such as those often undertaken by economists in developing countries. In our own work in Kenya, we typically expect 10% to 15% of attrition between survey rounds one year apart; i.e., we cannot find the same respondent one year later, even though the survey usually provides incentives on the order of half a daily wage. Now, imagine relying on others as business partners to deliver on promises in this context, relying on return visits from a health professional, or relying on public service delivery from government officials: It is likely that even higher rates of "attrition" are found in such situations, creating strong incentives to realize transactions now rather than later.

Finally, although the above risks are external, in our view there is a significant "internal" risk that creates incentives to act now in poor contexts: forgetting. In our own work, we have found that when individuals in Kenya have the opportunity to earn half a day's wage by simply sending a text message on a specified future date, they forget to perform this simple action at high rates, reaching about 50% for delays of a month (Haushofer 2015). When this risk is combined with the inferior availability of automatic transactions or reminder technology in resource-poor contexts, it creates strong incentives to want to act today. In line with this argument, our respondents in Kenya actually prefer to send the text message sooner rather than later, because they are aware of their own likelihood of forgetting.

In sum, P&N have outlined a provocative and compelling hypothesis for the prevalence of short-sighted behaviors in resource-poor contexts. Their hypothesis makes several testable predictions. Most importantly, it predicts that individuals in resource-poor contexts should want to act now for gains and losses: They should not only wish to consume immediately but also wish to incur costs that lead to larger benefits immediately rather than later. Our text-message study is one such example; one might imagine similar studies that use health behaviors, such as vaccination, as outcome variables. Future work of this kind promises to provide important insights into the mechanisms that drive behavior at the low end of the income distribution and point to interventions that could improve health and other outcomes in these populations.

NOTE

1. We use WHO data for mortality between ages 15 and 50 at age 15, assuming constant probability of death across this period for simplicity.

Deprived, but not depraved: Prosocial behavior is an adaptive response to lower socioeconomic status

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Abstract: Individuals of lower socioeconomic status (SES) display increased attentiveness to others and greater prosocial behavior compared to individuals of higher SES. We situate these effects within Pepper & Nettle's contextually appropriate response framework of SES. We argue that increased prosocial behavior is a contextually adaptive response for lower-SES individuals that serves to increase control over their more threatening social environments.

Individuals with lower socioeconomic status (SES) tend to be more empathetic, attentive to others, and prosocial than those with higher SES (Kraus et al. 2012; Piff & Moskowitz 2017; Piff et al. 2016). The prosocial tendencies of lower-SES individuals, who have fewer resources and reduced rank relative to upper-SES individuals, may seem irrational. We propose, however, that lower-SES individuals' other-regarding tendencies reflect adaptive responses to low personal control and greater vulnerability

to environmental threat. From this perspective, lower-SES individuals' seemingly irrational tendencies may reflect a deeper adaptive logic.

Pepper & Nettle (P&N) propose that lower SES relates to low personal control, which shapes a contextually appropriate constellation of risky behaviors: Due to reduced perceived control of future outcomes, it is contextually adaptive to exert control over the present, prioritizing short-term gains over long-term objectives. Here, we extend this framework of contextually appropriate responses beyond risk taking to recent findings in social psychology indicating that SES differences in control underlie divergent patterns of prosocial responding.

Increased material resources and relative rank afford higher-SES individuals greater personal control and autonomy and reduced vulnerability to social and environmental threats (Johnson & Krueger 2005; 2006; Kraus et al. 2009) – factors that give rise to an internal, self-oriented focus (i.e., greater attention to one's internal states and goals). By contrast, lower-SES individuals inhabit more threatening social environments (e.g., unstable jobs, unpredictable home lives; Evans et al. 2005), and limited resources constrain their ability to exercise personal control to buffer against threats. Because their lives are more susceptible to external influences, lower-SES individuals develop an external, other-oriented focus (i.e., greater vigilance to external contexts and individuals within them).

We have proposed and empirically tested the idea that reduced personal control causes lower-SES individuals to be more attuned to others' attitudes, intentions, and interior states. For instance, when explaining life outcomes (e.g., poverty, obesity), lower-SES individuals refer more to uncontrollable external forces, relative to higher-SES individuals. Those of lower SES are also more likely to factor third parties' emotions into attributions for a focal individual's emotions, reflecting a heightened attention to the social context. These SES-based patterns of social attribution are driven by SES differences in feelings of personal control (Kraus et al. 2009).

Lower-SES individuals' attentiveness to others is further evidenced by studies of visual attention and empathic processes. Individuals with lower SES spend more time looking at other human beings (Dietze & Knowles 2016), show more intense empathic responses to others' pain (Varnum et al. 2015), and display more physiological signs of concern and report higher levels of compassion when exposed to others' suffering (Stellar et al. 2012). In interactions with strangers, people of lower SES show more signs of engagement – such as making eye contact and nodding – compared to higher-SES individuals, who exhibit more disengagement (e.g., checking their cellphones; Kraus & Keltner 2009).

Increased attentiveness to others leads lower-SES individuals to prioritize others' needs more in social interactions (Piff 2014). In studies of prosocial behavior, individuals of lower SES volunteered more personal time to help a stranger in distress, and they donated more points (redeemable for cash) to an anonymous partner, compared to higher-SES individuals (Piff et al. 2010). Children from lower-SES families donated more prize tokens to an anonymous sick child than those from higher-SES households (Miller et al. 2015). Other studies find that higher-SES individuals are more likely to attempt to maximize self-interest by taking valued goods from others, lying in negotiations, and cheating to increase their chances of winning a prize (Piff et al. 2012a), whereas lower-SES individuals will cheat in a game to increase another person's chances of winning (Dubois et al. 2015).

Importantly, SES differences in prosocial behavior are observed when SES is measured and manipulated. For example, individuals made to feel lower in SES by comparing themselves to someone at the very top of the socioeconomic ladder endorse increased charitable donations relative to individuals primed to feel relatively higher in SES by comparing themselves to someone at the very bottom of the social ladder (Piff et al. 2010). The effect of manipulated SES appeared alongside an independent effect of measured SES (income) in the same study. These findings converge with P&N's account that contextual perceptions of relative deprivation (or advantage) are a proximal psychological mechanism underlying SES differences in behavior.

Why might lower-SES individuals be more prosocial? We posit that increased other-regard is an adaptive, contextually appropriate consequence of lower SES. Uncertainty and feelings of reduced personal control – both associated with lower SES – cause stress and prompt people to seek other sources of stability (e.g., Jonas et al. 2014; Piff et al. 2012b). Affiliative behaviors can serve as adaptive responses to reduced personal control and uncertainty (e.g., Hogg et al. 2007; Shuper et al. 2004). For example, experimentally inducing feelings of low personal control increased in-group identification and pro-group behavior, suggesting that collectives contribute to one's broader sense of control under personal uncertainty (Fritsche et al. 2013). Turning to others for social support and normative guidance can mitigate the negative effects of reduced personal control.

Guided by this reasoning, increased social attentiveness and prosociality among lower-SES individuals may be adaptive responses to reduced personal control, helping build and sustain interdependent networks of mutual aid that are vital coping strategies (Lamont 2000). Ongoing research is examining whether prosocial tendencies serve compensatory control functions among lower-SES individuals; cooperative communities may provide a form of "collective control" over threatening environments. Thus, we propose that prosocial tendencies are not irrational but instead reflect a deeper logic that – like the risky behaviors discussed by P&N – serve as adaptive and contextually appropriate responses to lower SES.

It's not just about the future: The present payoffs to behaviour vary in degree and kind between the rich and the poor

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Abstract: Pepper & Nettle offer a nuanced and humane view on poverty that should be required reading for policy makers, particularly those interested in "behaviour change" policy. We suggest, however, that the emphasis on "future-discounting" in this paper downplays the importance of differences in the payoffs to behaviours *in the present* and how these payoffs may be realised in different currencies.

Pepper & Nettle offer a new way of thinking about poverty that is theoretically motivated and empirically well-grounded and is derived from an impressive synthesis of research across disciplines. Their "contextually appropriate response" model provides a coherent framework for understanding behavioural differences between socioeconomic groups as appropriate responses to their different environments. This interpretation overturns notions of "irrational" behaviour among the uninformed or cognitively constrained poor and should be required reading for policy makers.

We are very enthusiastic about the paper and wish only to expand on one point that we believe warrants greater emphasis. The authors focus heavily on "future-discounting," arguing that those in relatively high extrinsic mortality environments should put less weight on the future benefits of behaviour, given the

lower likelihood of realising any benefits that could occur in the future. This is an extremely important and well-made point, but such a focus does seem to imply a "best of a bad job," constraint-driven strategy for the poor. The authors' definition of their model – "the contextually appropriate response perspective proposes that behaviours can be understood as appropriate responses to the challenges faced by an organism within a given context" (sect. 10, Glossary) – is actually broader than their focus on the present-orientation of the poor might suggest.

We think it would be helpful to emphasise that the costs and benefits of behaviours *in the present* differ by environmental context and that it is not just the *size* of the present versus future reward that matters but that the costs and benefits may also be realised in *different currencies* in different environments. The decisions of the poor may therefore lead to high payoffs in the present and cannot necessarily all be characterised as decisions that prioritise relatively small immediate rewards over relatively large future rewards (a point made by Sheehy-Skeffington & Rea 2017 in their recent review of how poverty influences decision making). This may be easier to see with non-health-related behaviours. For example, the authors mention the lower investment in education seen in poorer communities, which may be partly explained by the relative inability of the poor to reap the benefits of higher education later in life. But an additional important factor may be that there are benefits of leaving school early for the poor (not just in terms of immediate earnings – although these may be weighted more heavily by the poor, in line with the future-discounting argument – but also in the opportunity to gain skills that would be valuable in their particular context, and perhaps to enhance social status). In other words, it is not just about "future-discounting" or the (lack of) incentive to delay gratification due to higher extrinsic mortality experienced by the poor. For some behaviours, the poor may gain considerable benefits in the present that *do not exist for the rich*.

Further, the example of reproductive timing can be used to illustrate how the benefits of a particular behaviour in the present may actually be greater than those in the future in deprived environments. The more rapidly deteriorating health of the poor means worse maternal and child health outcomes for women who delay pregnancy (Goisis & Sigle-Rushton 2014) as well as a lower likelihood of having a (healthy) grandmother around to help with raising grandchildren. Delaying childbearing may actually bring costs to the poor, therefore, that are not felt by the rich, whose slower ageing process reduces the health consequences of delaying pregnancy, and who may be able to substitute (high-quality) paid childcare for any absence of grandmaternal help (Schaffnit & Sear, 2017). In addition, poorer women may benefit more from early pregnancy in terms of social status or social relationships. For example, qualitative work in the UK has suggested that early child bearing can "provide [women from deprived backgrounds] direction in life, the opportunity to take personal responsibility and, in some cases, a close personal relationship with a valued other" (Lee et al. 2004, 48) – outcomes that would likely not exist for those making decisions in a less deprived environment.

We emphasise the point that looking beyond the present-orientation of the poor is useful, because we think it may allow an even more nuanced and humane understanding of poverty and associated behaviours. This is important because of the considerable policy implications of the authors' model. We believe that the model's relevance to policy is not perhaps drawn out as explicitly and forcefully as it could be. The authors do make the point, if rather softly, that structural inequalities (i.e., environmental factors) need to be tackled rather than simply trying to influence behaviour itself. But we consider this to be a vitally important point, given the recent explosion of "behaviour change" policy, which is designed to "nudge" people into making the decisions that policy makers consider beneficial (a recent book on the topic describes a remarkable 83 theories of behaviour change, which are supposed to help policy makers derive appropriate behaviour change policies; see Michie et al. 2014). These policies are nuanced enough to understand that our cognitive biases make it difficult for us to make decisions that benefit us in the long term but may neglect the possibility that different behaviours bring different costs and benefits in different environments. Such neglect may do more harm than good, if behaviour change policies differentially influence the rich and the poor, and especially if they have adverse effects on the poor. This paper drives home the vital importance of fully understanding the impact of the environment on the decision-making process, and how it affects the costs and benefits of behaviour in the present and the future. The importance of the environment in influencing one's behaviour should also be taken very seriously by policy makers, who typically inhabit very different environments than those of the individuals whose behaviours they are trying to change (Hodgson 2011). In other words, the rich should not make (behaviour change) policy for the poor – at least not without reading this article first.

The link between deprivation and its behavioural constellation is confounded by genetic factors

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Abstract: Most research cited throughout Pepper & Nettle's (P&N's) target article is correlational and suffers from a serious genetic confound that renders it of little evidentiary value. Of correlational findings that are not confounded, P&N ignore examples that contradict their model. Further, P&N's claim that evolutionary models explaining between-species differences in behaviour can be used to understand that corresponding individual differences lack any evidence.

We value Pepper & Nettle's (P&N's) target article as an attempt to integrate multiple disciplines in understanding a problem of broad societal importance. However, we do not believe the proposed model has a sound basis in theory or evidence.

First, the model suffers from a fundamental disconnect in its theoretical foundation. P&N's evolutionary model is based on their claim that "principles that were originally used to understand the selective forces leading to the evolution of traits over generations … can be applied to enhance our understanding of how behaviour is shaped by people's environments within their lifetimes" (sect. 3, para. 1). The authors do not cite theory or evidence to support this crucial claim. We believe that this kind of thinking, although widespread in evolutionary psychology, is misguided. The Darwinian reasons a species is the way it is (and is different from other species) pertain to a process over many generations of selection for genes that are reproductively advantageous in the environments the species occupies. This process genetically tailors each species to its environment. There is no *equivalent* process that differentially tailors each *individual* within a species to his or her personal environment. Therefore, the same Darwinian models used to explain between-species differences in behaviour and development cannot be applied to corresponding between-individual differences.

Second, the empirical basis of P&N's model is weak. Most of the cited findings linking deprivation with future-discounting and related behaviours are correlational and suffer from a confound that renders them uninformative with respect to the proposed model (see Zietsch 2016 for a broader discussion of this issue with facultative calibration models). Specifically, genetic

variation influences individual differences in childhood socioeconomic conditions and future-discounting (and in turn the "behavioural constellation of deprivation" [BCD]). P&N attempt to address this genetic confound by briefly discussing a single twin study in which they acknowledge that identical twins showed greater similarity than nonidentical twins on delay-discounting tasks (Anokhin et al. 2011). However, they do not report the variance components estimates: Genetic variation accounted for 30% and 51% of variation in delay discounting at ages 12 and 14, respectively, while none of the variation in delay discounting was attributable to variation in the environment shared by twin pairs (shared environment), which included, for example, the socioeconomic status (SES), neighbourhood crime rate, and home environment in which the twins were raised. This pattern of results was more recently replicated by Anokhin et al. (2015), with estimates of substantial heritability but no effect of the shared environment. Regarding SES as a dependent variable, massive molecular genetic studies have shown that variation in social deprivation and household income can be partly attributed to common genetic variants (Hill et al. 2016; Trzaskowski et al. 2014) and that the same genetic variants underlying SES also underlie educational attainment and intelligence scores (Marioni et al. 2014). An explanation of the correlations between SES and BCD traits that is consistent with all of these findings is that future-discounting parents tend to provide their children with a lower SES childhood environment and with genes predisposing them to future-discounting (and BCD traits) in adulthood. In contrast, P&N's model, in which the socioeconomic environment is a main causal driver of variation in future-discounting and BCD traits, is difficult to reconcile with the behavioural genetic findings that the shared environment cannot explain individual differences in future-discounting.

Muddying the waters with regard to the problematic genetic evidence on future-discounting, P&N invoke research on gene-by-environment (GxE) interactions (sect. 4.5, para. 2). The cited evidence, though, does not reflect the current state of the field. The claim that "children living in poverty are much more heavily constrained by their environments than by any constitutional limits" (sect. 4.5, para. 2) is based on a finding from one underpowered study (Turkheimer et al. 2003) that has fared poorly in much larger replications, which show instead that the genetic effect on IQ is similarly high in low-SES and high-SES families (e.g., Hanscombe et al. 2012). P&N's only other citation on the topic is of a candidate-GxE study (i.e., Sweitzer et al. 2013) of the kind that was already discredited at the time of that publication because of a record of extremely low replicability (Hewitt 2012). None of this evidence, or any other that we know of, alleviates the aforementioned genetic confound that undermines much of the correlational evidence cited in the target article.

Not all correlational evidence is subject to the genetic confound. For example, P&N report some cross-country associations between extrinsic mortality risk and fast-tracking reproduction that are consistent with their model. However, it is surprising in an article reviewing the effects of mortality risk and future-uncertainty that data were not brought to bear from major periods of high mortality risk, uncertainty, and/or deprivation, such as the Great Depression and World War II. As it turns out, during this time, birthrates sharply decreased and only recovered once prosperity and safety returned some 20 years later (Fishback et al. 2007). Under P&N's reasoning, the onset of deprivation and high risk should have increased birthrates as people discounted the consideration of postponing for a future they may never see, whereas the observed outcomes were the opposite. The 2007–2008 financial crisis also created considerable future-uncertainty, and the same trend of falling and recovering birthrates was again observed (Livingston 2011). A different sort of example can be seen in data on families emigrating from Mexico to the United States – that is, a country in which the homicide rate is three times lower and the gross domestic product is eight times higher. Mexicans living in the relatively safe and prosperous United States have more children than those living in Mexico (Camarota 2005) – opposite to what P&N's model would seem to predict. Further, analysis of native- and foreign-born fertility rates finds that Mexicans who emigrated to the United States as children had lower mean ages at first birth than adult entrants (Glusker 2003).

To properly evaluate P&N's model, we need relevant findings that are sampled in a way that is unbiased with respect to their match to the theory. The target article does not meet this need; P&N admit that they only acknowledge the works that best illustrate the story they want to tell (sect. 1, para. 4). A model will always look like a good fit with the data when only the best-fitting data are presented; in this case, once important disconfirmatory evidence is considered as well – that is, the behavioural genetic findings and other observations we have mentioned here – the model seems to us unlikely at best.

Intertemporal impulsivity can also arise from persistent failure of long-term plans

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Abstract: We suggest that steep intertemporal discounting in individuals of low socioeconomic status (SES) may arise as a rational metacognitive adaptation to experiencing planning and control failures in long-term plans. Low SES individuals' plans fail more frequently because they operate close to budgetary boundaries, in turn because they consistently operate with limited budgets of money, status, trust, or other forms of social utility.

Pepper & Nettle's (P&N's) central claim is that intertemporal impulsivity is a function of rational adaptation to shorter time horizons, in turn drawn from an inference of mortality risk. The identification of differential temporal discounting as a unifying principle explaining multiple behaviour patterns seen under conditions of deprivation is a timely and compelling contribution of this target article. However, P&N's association of shorter planning horizons with exogenous mortality risk does not appear as compelling and seems to be an overextension of evolutionary psychology ideas that have historically lacked strong empirical justification.

In particular, the relationship between exogenous mortality risk and crime rates, identified in Chicago neighbourhoods (Wilson & Daly 1997), does not scale up well when we measure correlations between, to take just two examples, state-level life expectancy (Suryanarayana et al. 2011) and overall crime rates among states in India (National Crime Records Bureau 2012) (see Fig. 1a) and cross-country life expectancy (United Nations Department of Economic and Social Affairs 2015) and intentional homicide rates (United Nations Office on Drugs and Crime 2013) (see Fig. 1b). The strength of this proposed causal link is also called into question by large differences in behaviour patterns between low SES populations in the United States and in developing countries. For example, P&N review an extensive literature that correlates low SES with a propensity to not save. Empirically, while households in the top income quintile (mean income $140,000/year as of the year 2000, according to the Tax Policy Center 2017) in the United States save around 23% of their income per year (Dynan et al. 2000), the average savings rate in China with

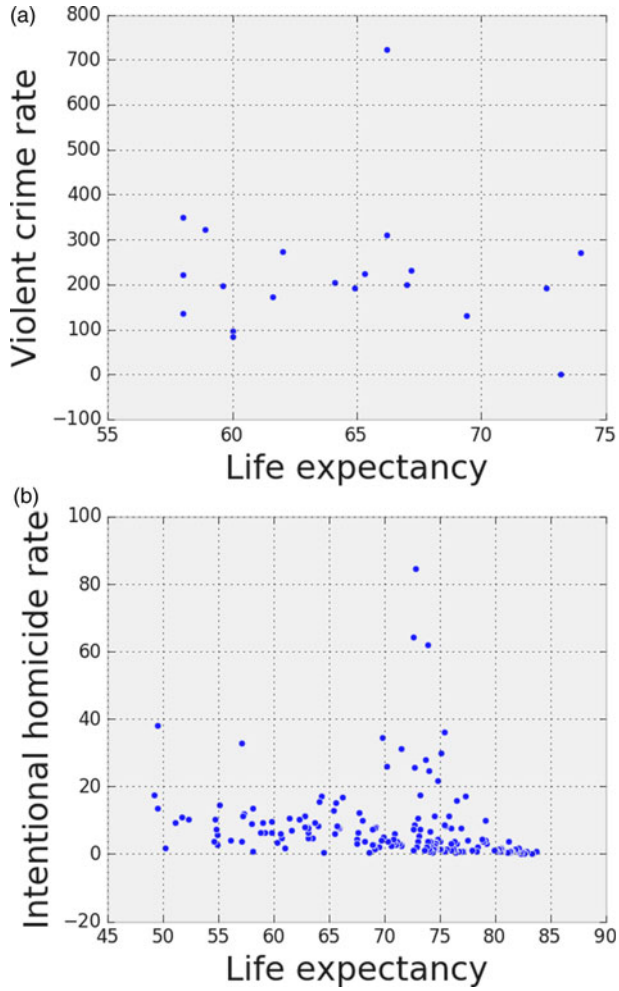

Figure 1 (Srivastava & Srinivasan). No evidence of relationship between exogenous mortality risk and crime rates in two large datasets. (a) Scatter plot of life expectancy at birth versus crime rate (per 100,000 capita) among states in India. (b) Scatter plot of life expectancy at birth versus intentional homicide rate across countries of the world.

a purchasing power parity (PPP) adjusted average household income of $14,450 per year (World Bank, n.d.) was 38% as of 2014 (OECD 2017).

P&N also do not engage with some normatively positive behaviour reliably observed in low SES subjects – that is, greater prosocial behaviour. *Prima facie*, prosociality appears to fall within the ambit of the low SES behaviour; an intuitive association with intertemporal preference would suggest that low SES participants would put their payoff from winning the present transaction above the possible long-term benefits of prosocial behaviour. Yet Piff et al. (2010) have shown in controlled lab experiments that low SES individuals are more generous, charitable, and helpful than high SES individuals. This experiment corroborates survey-based measurements, which also document greater charity, as a function of income levels, among people with low incomes (Greve 2009). The question of how greater mortality risk might lead to greater charity is interesting theoretically, but it is perhaps even more important to mention such *positive* behaviour in low SES individuals in light of the putatively *negative* behaviours documented in the target article.

These disconnects with empirical data motivate looking for alternative causal mechanisms than mortality risk assessment by which low SES might lead to shorter planning horizons. We argue for an alternative source of intertemporal impulsivity that is not well described in the present article. We have been investigating the relationship between people's sense of control over their environments and their subjective sense of *agency*. Experiments on event-control and agency have shown that the sense of agency is strongly sensitive to the time scale on which people can effectively exercise control (Kumar & Srinivasan 2014; 2017). A natural corollary to this finding is that to maintain their sense of agency, agents may allocate mental resources preferentially to those time scales they find they can most effectively act upon.

Low SES individuals will naturally find planning and controlling actions at long time scales inefficient, because plans with low resource reservoirs underpinning them are more susceptible to being overturned by small random socioeconomic fluctuations – for example, price increases or delayed payments – than plans with substantial resource reservoirs. Thus, our alternative hypothesis is that the reason low SES subjects demonstrate steeper time discounting is that they have greater experience with planning and control failures caused by always operating close to budgetary boundaries, which in turn arise inevitably from having to consistently operate with limited budgets of money, status, trust, or other forms of social utility. Repeated encounters with such planning breakdowns will cause low resource agents to make shorter-time-horizon plans as a rational adaptation to planning failures with long-duration plans.

Interestingly, such planning failures need not just be caused by budget overruns; they can also be directly induced through experimenter intervention. This latter modality of planning failure is seen, for instance, in the experimental design of Kidd et al. (2013), who find that children paired with experimenters who had reneged on previous promises were more likely to prefer small assured rewards in the present than large rewards in the future. Thus, Kidd et al. (2013) are able to reproduce the central phenomenon of low SES behaviour – greater intertemporal discounting – using a simple trust-based manipulation. Our proposal, relating intertemporal discounting to metacognitive preference for information processing on useful time scales, is entirely compatible with this explanation. Children paired with unreliable experimenters obtain experience with planning failures on longer time scales and respond by promoting consideration of shorter time-scale plans, resulting in steeper intertemporal discounting.

Our proposal is also compatible with the finding of greater prosocial behaviour among low SES individuals. Deemphasising long-term plans reduces the opportunity cost of distributing economic surplus funds in the present – thus, the seemingly contradictory finding that people with smaller incomes prove to be more generous (in percentage terms). Once immediate needs are met, reduced planning on longer time horizons is expected to materialise in the precise spectrum of *carpe diem* behaviour seen empirically – lower savings rates, greater hedonic consumption, and greater charitable giving.

Health behaviour, extrinsic risks, and the exceptions to the rule

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Abstract: Pepper & Nettle make a compelling case for how evolutionary thinking can help explain behaviours that cluster with deprivation. The role of extrinsic mortality risk in driving behaviour is probably important, but

strong evidence is still lacking. By thinking carefully about behaviours seemingly at odds with an evolutionary life history perspective, we can gain important insights that will help refine theory.

In his book *The Health Gap*, Michael Marmot (2015), who conducted the classic Whitehall study of social determinants of health, asks: "Why treat people and send them back to the conditions that made them sick?" (p. 1). Thus, a fundamental challenge for public health is to understand the socioecological contributors to ill health, perhaps most importantly the factors that lead individuals to make decisions detrimental to their well-being. Building on the insights of evolutionary life history theory (Hill 1993; Stearns 1992), Pepper & Nettle (P&N) outline the case for high extrinsic mortality risk (EMR) as a key driver of seemingly "bad behaviour." The argument they present is both well reasoned and intuitive, and I find little to disagree with. However, in this comment focusing on health behaviour, I make two points: (1) The evidence for a strong association between EMR and detrimental health behaviour is not as substantive as the target article conveys; and (2) there are several areas where observed health behaviour suggests that EMR plays a relatively inconsequential role. It is only by interrogating these areas of apparent weak support that we can refine our understanding and better integrate evolutionary thinking with existing public health research and policy.

Many of the studies cited by P&N to support the idea that EMR predicts poor health behaviour rely on suboptimal methodologies, including crude aggregates of mortality rates and a failure to isolate the effect of individual socioeconomic status (SES) from EMR. A combination of more fine-grained measures of local mortality rates that distinguish between causes of death (extrinsic and intrinsic) and individual-level characteristics is needed to satisfactorily address the question at hand. Studies that fulfil these criteria have found that the effect of the EMR on reproductive timing and health behaviours is small in comparison to the effect of individual SES, and that area crime rates or the adult sex ratio may be just as important (Uggla & Mace 2015; 2016). In the same developed population, evidence suggested that EMR positively predicted preventable death among men but not among women, and that EMR effects were greater for men with low SES than men with high SES (Uggla & Mace 2015). Such heterogeneity does not refute a model with EMR as a key driver of behaviour, but it does suggest that its predictive power may vary considerably within populations.

Another source of evidence P&N use is priming studies. Studies relying on self-rated mortality risk can be informative, but they are prone to response biases, and the ecological validity of such studies is questionable. It is therefore important to test whether individuals' reported risks map onto the ecological conditions to which they are exposed. A recent study that compared perceived and actual area characteristics in Belfast, Northern Ireland, found that whether individuals accurately gauged their neighbourhood varied with the type of characteristic; perceptions of median age at death were more accurate than perceptions of local levels of crime and the local adult sex ratio (Gilbert et al. 2016). P&N do acknowledge that individuals might respond to other extrinsic factors, such as illnesses, but it is only by testing these factors alongside the EMR and comparing their relative effects that we can achieve a fuller understanding of the root causes of ill health.

The observation that many health interventions achieve behavioural change without altering the individual's extrinsic risks also raises questions about how central extrinsic risks are for health behaviour. Meta-reviews of health interventions targeting, for example, weight loss and physical activity, have presented convincing results even when interventions are minor, such as keeping a food diary or practising mindfulness (Burke et al. 2011; Katterman et al. 2014). If individuals with low SES are more likely to have poor diets and be overweight because of higher extrinsic risks, why would they change their behaviours in response to interventions that leave their overall conditions unchanged? In many instances, these interventions do not provide any additional information on the health behaviour, which suggests that their success is likely explained by factors other than educational components. Notably, even in developing contexts, where life may be short and uncertain, studies repeatedly show that when women receive cash, they often spend it on causes that benefit their families' well-being in the long run rather than on short-term expenditures (Banerjee & Duflo 2012). These examples are not mutually exclusive to a model invoking extrinsic risks, but they do suggest that further thinking is necessary to explain the malleability of health behaviours.

Finally, a sticky point is why some health behaviours with well-known health risks, such as smoking, show a clear SES gradient, whereas alcohol misuse – which in many ways is a comparable behaviour – does not. Excessive alcohol consumption is a leading cause of premature mortality in developed countries (World Health Organization 2014), but its relationship with SES is a little more complex than P&N depict. Low-SES individuals have higher risk of alcohol-related death, yet evidence suggests that drinking patterns are similar across SES groups with regard to overall consumption and to binge drinking (Mäkelä & Paljärvi 2008). Do high-SES individuals drink excessive amounts of alcohol because they know it is unlikely to end badly due to better social support networks and higher compliance to treatment? Or is it because the health risks of alcohol are not as severe for high-SES individuals due to their otherwise healthy habits (e.g., better diets)? A greater emphasis on compensation effects and the interplay between different health behaviours might provide fruitful insights on this topic. The association between low SES and poor health behaviours is strong, but paying greater attention to behaviours that do not neatly fit the pattern can help refine theory and offer a better understanding of health inequalities and their causes.

Authors' Response

Strengths, altered investment, risk management, and other elaborations on the behavioural constellation of deprivation

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Abstract: We are grateful to have received so many insightful commentaries from interested colleagues regarding our proposed behavioural constellation of deprivation (BCD) and our thoughts on its causes and consequences. In this response article, we offer some clarifications regarding our perspective and tackle some common misperceptions, including, for example, assumptions that the BCD is adaptive and that it should include all behaviours that vary with socioeconomic status. We then welcome some excellent proposals for extensions and modifications of our ideas, such as the conceptualisation of the BCD as a risk-management strategy and the calls for a greater focus on strengths and differential investment rather than deficits and disinvestment. Finally, we highlight some insightful explorations of the implications of our ideas for ethics, policy, and practice.

We are extremely grateful to have had the rare opportunity to receive, and respond to, feedback from so many of our esteemed colleagues on the ideas presented in our target article. They have done an excellent job of critiquing, extending, and exploring the implications of the perspective we presented for enhancing the understanding of socioeconomic variation in behaviour and health outcomes.

In the target article, we made the case that a cluster of behaviours, which we call the behavioural constellation of deprivation (BCD), is associated with lower socioeconomic status (SES). We proposed that this BCD results partly from the relatively limited personal control experienced by people of lower SES. We suggested that limited personal control curtails the extent to which people can expect to realise deferred rewards, leading to more present-oriented behaviour in a range of domains. In the target article, we emphasised that we see these present-oriented behaviours as a contextually appropriate response to structural and ecological factors rather than as pathology or a failure of willpower – a perspective that some of our commentators engaged with in their responses. The target article also used principles from evolutionary theoretical models, such as feedback loops, to explore ways in which socioeconomic inequalities might become amplified and embedded – concepts that some of our commentators expanded upon. We also summarised some of the potential mechanisms underlying the BCD, and our commentators helpfully added to this list of mechanisms, generating a more in-depth picture of the interactions between potential mechanisms and of how they might alter with the different trade-offs experienced throughout the life course. Our target article also briefly touched on the implications of the perspective we presented for ethics, policy, and practice. We thank the commentators who have used their expertise in applied behavioural science to further elaborate upon the practical and societal implications of the ideas we put forward.

Our response to the commentaries is organised into themes. The sections within R1 clarify the goals of the target article. For example, we discuss which behaviours the BCD is meant to include and which are intentionally omitted (R1.1). In R2, we offer some clarifications regarding misconceptions about our arguments that are evident in the commentaries, such as the perception that our ultimate explanation is mutually exclusive of explanations at the proximate level (R2.1). In R3, we tackle criticisms from **Sherlock & Zietsch**, who object to a founding assumption of our work: that principles originally used to understand the evolution of traits over generations can enhance our understanding of how behaviour is shaped by environment within an individual's lifetime. In R4, we emphasise and discuss some of the excellent suggestions that our commentators put forward for deepening and extending our framework. These include the ideas that the BCD can be viewed as a risk-management strategy, offering a more parsimonious explanation for a broader constellation of behaviours (R4.1); that a physiological constellation of deprivation exists, and entails similar trade-offs to the behavioural one (R4.2); and that the contextually appropriate response perspective should include a greater focus on strengths and differential investment in addition to considering deficits and disinvestment (R4.3). In R5, we highlight commentaries that presented valuable analyses of the implications of our perspective for ethics, policy, and practice.

R1. We told a simple story, for didactic purposes

Our target article tells a simple and, in some respects, simplified story. In part, we took this approach because it is impossible in any one paper to discuss all points that may be deemed relevant or to cite all available evidence. Additionally, we wanted to ensure that our key messages were not lost in a cloud of caveats, alternatives, and details. Faced with a trade-off between illustrating core principles in a memorable and digestible manner and including the nuance that some readers might crave, we tended more towards discussing core concepts than specific details. Inevitably, this means that some of the critiques of our target article come from colleagues who wanted to see us discuss or explain more types of socioeconomically patterned behaviour, more of the potential predictors of those behaviours, or more of the possible underlying mechanisms. In this section, we emphasise that the perspective we present in the target article was not intended to serve as a "theory of everything" that can be applied in all contexts to all behaviours (R1.1). We also recognize that the target article was by no means intended to identify all potential mechanisms underlying the BCD (R1.2) or all of its potential driving forces (R1.3).

R1.1. The BCD should not incorporate all behaviours associated with SES, and SES-behaviour associations may vary with context

In our target article, we presented a range of behaviours that appear to be somewhat consistently socioeconomically patterned, with their defining common feature being that they can all be conceived of as a response to being faced with trade-offs between present and future outcomes (our BCD). The BCD is not intended to incorporate *all* behaviours that vary with SES, nor is the contextually appropriate response perspective, presented in relation to the BCD behaviours, intended to explain *all* socioeconomic differences in behaviour. We simply offered a possible means of understanding this particular cluster of behaviours (the BCD behaviours listed in sect. 2 of the target article) as a contextually appropriate response to a common explanatory factor – the strength of the present-future trade-offs that people face.

We also did not mean to suggest that *all* variation in BCD behaviours can be explained by these present-future trade-offs. It is unlikely that any phenomenon, particularly one as complex as patterns of human behaviour, can be pinned to a single explanatory factor. We simply propose that a meaningful proportion of the variation in BCD behaviours should be attributable, via appropriate psychological pathways, to individuals' experiences of future-limiting factors. (This does not mean that we do not acknowledge that some other meaningful portion of variation in BCD behaviours might be explained by other factors, such as the experiences of relative disadvantage discussed by **Novakowski & Mishra**).

In response to our target article, **Breugelmans, Plantinga, Zeelenberg, Poluektova, & Efremova** (**Breugelmans et al.**) argue that the BCD "(1) overestimates the coherence of the various behaviors associated with poverty and (2) underrepresents the range of behaviors that should be included in such a constellation" (para. 1). This would certainly be true, had we intended to argue

that *all* socioeconomically patterned behaviours should be included in the BCD. Perhaps the response of Breugelmans et al. indicates that our chosen title, "the behavioural constellation of deprivation," is a little aggrandised. Nonetheless, we believe that this label is more memorable and relatable than a more-accurate but less-wieldy title, such as "a cluster of often socioeconomically patterned behaviours united by their connection to temporal trade-offs."

Several commentaries raise the issue of socioeconomic variation in social and cooperative behaviour, either assuming it to be part of the BCD or arguing for its inclusion. For example, **Grossmann & Varnum** point out that lower SES is associated with greater accuracy in identifying others' emotions and in compassion towards others – perhaps because in-group coordination can help buffer against scarcity and external threats. **Robinson & Piff** argue that increased prosocial behaviour among lower-SES individuals may serve to provide increased control in the context of more-threatening social environments. **Srivastava & Srinivasan** highlight the trend towards more charitable and prosocial behaviour in lower-SES individuals, suggesting that our target article ought to have put more emphasis on the existence of such positive behaviours among people of lower SES. In response to these commentaries, we wish to emphasise that we are open to the extension of the BCD to incorporate social and cooperative behaviours that vary with SES. However, such extension would require demonstrating that these behaviours share the same underlying logic as the BCD behaviours we outlined in the target article. If they do not, they may well be socially patterned but not usefully viewed as part of the BCD as we define it (see also section R4.1).

Pearson & van der Linden discuss the specific example of pro-environmental concern – something they say is more common among those of lower SES than of higher SES. They rightly point out that environmental behaviours entail an intertemporal trade-off. However, these behaviours also involve other dimensions, such as common goods problems, and the harms and the costs of mitigation fall differentially on different social groups. As such, the proportion of variation in environmental behaviour that could be explained by exposure to future-limiting factors may be somewhat limited. Thus, as highlighted by these commentaries, to expand the BCD to incorporate a broader range of socioeconomically patterned behaviours, other explanatory factors, such as social context, would need to be taken into account in our explanation. We prefer in this instance to put forward a simple causal account of a narrow range of behaviours rather than a complete but multifactorial treatment of all SES-patterned behaviours.

Just as we did not mean to imply that the BCD should include *all* socioeconomically patterned behaviours, we did not intend to suggest that the elements of the BCD should be apparent among *all* lower-SES individuals or in *all* contexts. In our target article, we attempted to dispel such ideas with section 8.1, "The BCD only applies on average." However, we may not have made our point sufficiently clear: There will be situations in which there are limited or no SES differences in experiences of the intertemporal trade-offs that we argue drive the BCD. That is, if the BCD is driven by trade-offs that tend to be more common at lower SES, rather than by SES per se, then the association between SES and those trade-offs is required for the existence of any relationship between SES and BCD behaviours.

If the BCD is not driven by SES per se, developing hypotheses about which specific facets of lower- or higher-SES life affect the BCD behaviours we are interested in can lead to more precise measures, allowing us to account for more of the variation in those behaviours. For example, our contextually appropriate response perspective would lead us to predict that exposure to extrinsic (uncontrollable) mortality risk (which tends to be greater at lower SES) should be a better predictor of health behaviour than SES itself (which is associated with, but does not necessarily directly influence, health behaviour). Indeed, in a survey of North American adults, we found that those of lower subjective SES reported making less effort to look after their health and perceived a greater portion of their mortality risk to be extrinsic. This relationship between SES and self-reported health behaviour was entirely mediated by respondents' perceived extrinsic mortality risk. That is, SES was no longer a predictor of health behaviour once perceived extrinsic mortality risk was controlled for (Pepper & Nettle 2014b). Although this finding requires further replication and elucidation, it suggests that, in some cases, perceived extrinsic mortality risk may provide a more precise predictor or control measure for studies of health behaviour than measures of SES. Our target article and its commentaries list various other future-limiting factors that, like perceived extrinsic mortality risk, have the potential to account for more of the variation in BCD behaviours than measures of SES itself.

Some BCD behaviours may be more strongly influenced by other factors at times, making explanations regarding intertemporal trade-offs less applicable. For example, **Daly Ramos, & Perry** point out that, although research from wealthier countries supports the existence of the BCD as we define it, the patterns we have described do not seem to generalise to Latin American populations. They state that research in Argentina and Mexico shows the use of alcohol, drugs, and tobacco to be more common among those of higher SES – perhaps because poverty in such countries is more extreme, and those at the bottom of the SES ladder lack the financial means to use such substances. Such examples highlight the need to consider context: Moderating and limiting factors will apply.

R1.2. We didn't set out to list all of the proximate mechanisms that might underlie the BCD

Our commentators have done an admirable job of adding richness to the picture regarding potential proximate mechanisms of the BCD. They have discussed potential proximate psychological mechanisms, such as optimism and pessimism (**Mittal & Griskevicius**), envy (**Novakowski & Mishra**), and self-control (**Carmel & Leiser**), as well as physiological mechanisms, such as differential immunological investment (**Garcia & Blackwell**) and DNA methylation (**Brown & Olding**). In the target article, we didn't attempt to list all possible proximate mechanisms that might underlie the BCD. We hoped that our commentators would add detail in this regard, and we are grateful to them for having done so.

Many of our commentators appear to have understood that our attempt to explain the BCD was largely at the ultimate rather than at the proximate level. That is, we aimed

to explain the BCD in terms of the payoffs to BCD behaviours in the context of deprivation rather than in terms of such factors as self-control, which we view as psychological mechanisms underpinning BCD behaviours. In section 4 of the target article, we emphasised that proximate explanations do not preclude ultimate ones – rather, they are complementary, with ultimate explanations telling us why a behaviour should occur in a given context, and proximate ones telling us how that behaviour is delivered via cognitive or physiological mechanisms (Scott-Phillips et al. 2011). Despite this effort, some commentators proffered proximate explanations for the BCD as though they were mutually exclusive of our ultimate explanation. For example, **Doebel, Michaelson, & Munakata** (**Doebel et al.**) suggest that we made a false dichotomy by contrasting personal control with self-control abilities. However, under the perspective we put forward, self-control is considered a proximate psychological mechanism underpinning the link between limited personal control (over future-limiting factors) and BCD behaviours. We cover this issue in more detail in R2.1, where we discuss whether the "alternative" explanations offered by commentators are truly separate accounts.

R1.3. We didn't intend to pretend that mortality is the beginning and the end

In section 2.3 of the target article, we focussed on the specific example of extrinsic mortality risk as a future-limiting factor driving the BCD. We did this not only because uncontrollable mortality risk is an extreme example of a future-limiting factor, but also because it has been extensively examined in pertinent evolutionary models. In section 2.4 of the target article, we acknowledged that many other future-limiting factors will be important, giving some examples. Nonetheless, such commentators as **Uggla** and **Riis-Vestergaard & Haushofer** object to our focus on extrinsic mortality risk as an example. Uggla highlights studies that show small effects of area-level extrinsic mortality in comparison to individual-level measures of SES. Meanwhile Riis-Vestergaard & Haushofer suggest that observed rates of temporal discounting across countries are too high to be accounted for by extrinsic mortality risk alone. Of course, they are most likely right: Although extrinsic mortality risk offers a convenient illustrative example that is easy to grasp, in reality, people living with deprivation face a multitude of subtle and varied future-limiting factors that are likely to have a cumulative effect. Indeed, Riis-Vestergaard & Haushofer offer some additional examples of such factors, including liquidity constraints, income uncertainty, and the unpredictability of the social environment. Other commentaries expand upon this list by discussing such influences as capital constraints (**Rickard**), low cultural consonance (**Quinlan**), and the limited control experienced as a result of operating close to budgetary boundaries (**Srivastava & Srinivasan**).

R2. Misperceptions that suggest a need for further clarification

In our target article, we aimed to address potential misinterpretations of our perspective by dedicating section 8 to clarifications and caveats. Nonetheless, it seems that there is always room for further clarification. In this section of our response, we discuss some "alternative" explanations for the BCD that our commentators put forward and suggest that they are not necessarily mutually exclusive of the explanations we offered in the target article (R2.1). We also discuss some of the terms that we used in the target article and explain why we actively avoided the use of more-obvious alternative terminology. For example, we explain why we avoided mention of "life history theory" in the target article (R2.2) and why we described the BCD as a "contextually appropriate response" rather than as "adaptive," "rational," "logical," or "optimal" (R2.3).

R2.1. "Alternative" hypotheses that are not mutually exclusive to ours

A number of our commentators proffered explanations for the BCD, which they either explicitly state or imply are alternative to ours. For example, **Srivastava & Srinivasan** agree that differences in temporal discounting may underlie a portion of observed socioeconomic differences in behaviour, but they suggest that extrinsic mortality risk is not sufficient to explain these differences. They instead posit that "our *alternative hypothesis* is that the reason low SES subjects demonstrate steeper time discounting is that they have greater experience with planning and control failures caused by always operating close to budgetary boundaries, which in turn arise inevitably from having to consistently operate with limited budgets of money, status, trust, or other forms of social utility" (para. 5; emphasis added). We agree that extrinsic mortality risk cannot be sufficient to explain all socioeconomic variation in behaviours related to temporal discounting. Indeed, we emphasise in section R1.3 that we did not intend to suggest this.

We also agree that people of lower SES are more likely to experience what **Srivastava & Srinivasan** term "planning and control failures" (para. 5) that affect their temporal discounting. Indeed, we discussed this in section 2.2 of our target article, which outlines the ways in which having limited wealth, education, or social connections can curtail personal control and thereby the ability to influence future outcomes. We used limited control over mortality risk as an example in the target article but also included a section on other factors (2.4). To this section, we could easily add the explanation given by Srivastava & Srinivasan: "Low SES individuals will naturally find planning and controlling actions at long time scales inefficient, because plans with low resource reservoirs underpinning them are more susceptible to being overturned by small random socioeconomic fluctuations" (para. 5). This usefully illustrated another future-limiting factor experienced at lower SES – limited reserves increase vulnerability to socioeconomic perturbations. As such, this is not an *alternative* hypothesis, but a complementary one.

Some other commentators suggested that *proximate* mechanisms, such as self-control, are alternative explanations to the *ultimate* one we outlined in the target article. **Doebel et al.** suggest that "contrasting contextual factors with self-control may be a false dichotomy" (para. 4). This is not a dichotomy we intended to make, because we view self-control as a mechanism that calibrates behavioural responses to contextual factors. In the same vein, **Carmel**

& Leiser "substitute a different psychological explanation and argue that self-control rather than 'extrinsic mortality risk' explains those behaviors" (para. 1). They argue that "short-sighted" decisions can be "explained by the limited attention span brought about by financial scarcity" (para. 2). However, in our target article (sect. 4), and in section R1.2 of this response, we emphasise that we view individual psychological mechanisms, such as self-control, as proximate pathways delivering the BCD in response to its ultimate cause – lack of control over future outcomes. As such, we do not view explanations invoking such concepts as self-control as being alternative to our explanation. These explanations work together at different levels, ours being ultimate, theirs being proximate.

As we stated in the target article, viewing these proximate and ultimate explanations as part of the same picture alters our perspective regarding such concepts as self-control: Rather than being a mysterious internal resource that sometimes fails us due to cognitive constraints, such as limited attention span, self-control can be viewed as a psychological mechanism guiding our behavioural response to the trade-offs we face. This is the essence of the contextually appropriate response perspective. It is important, because it suggests that rather than pejoratively viewing present-oriented decisions as resulting from a failure to muster sufficient cognitive resources to be future-oriented, we might view them as appropriate decisions for that person given their circumstances.

In addition to offering putatively alternative explanations that conflate levels of explanation, some commentators mistakenly suggest that evidence in support of phenomena not explained in our target article can be taken as evidence against the perspective we outlined. For example, **Rad & Ginges** present their finding that Muslim participants who were fasting for Ramadan became more risk and loss averse than those who were not. Because fasting entails the experience of self-induced scarcity (it is within individual control), they propose that it should not alter decision making if low control does elicit BCD behaviours. Their finding is interesting for a number of reasons, but it does not undermine our hypothesis that low control drives the BCD: Evidence that people become more risk averse under self-induced scarcity is not tantamount to evidence that people do not become more risk averse under involuntary scarcity. Moreover, there are many cases in which humans activate through voluntarily action mechanisms that evolved to respond to involuntary experiences. Self-imposed dieting makes people hungry, and self-imposed viewing of horror movies makes them scared. This hardly refutes the idea that fear is an evolved mechanism for responding to threats experienced involuntarily.

R2.2. We intentionally avoided referring to life history theory

We actively avoided characterising our explanation for the BCD as "life history theory" in our target article, although the term might be relevant. Despite this omission, many of our commentators' responses suggest that they assumed our contextually appropriate response explanation for the BCD to be life history theory repackaged (**Brown & Olding**; **Grossmann & Varnum**; **Jones**; **Mittal & Griskevicius**; **Quinlan**; **Uggla**). We therefore take this opportunity to clarify why the BCD should not be conceptualised as a life history strategy and why we do not wish to claim that it can be explained by life history theory.

Our chief motivation was that in the human sciences, life history theory has come to have several distinct referents. Life-history theory was originally developed to explain species-typical patterns of growth and reproduction in terms of fitness maximisation in a given ecological context (Promislow & Harvey 1990; Stearns 1977; 1992). In this sense, life history theory is really a set of methods (formal approaches for explicitly modelling how selection would be expected to act on patterns of growth and reproduction) rather than any particular set of empirical claims. Indeed, one of the main lessons of this kind of modelling is that selection can favour many different things, depending on detailed assumptions about the ecology, the biology of the organism, demography, and other such factors. Thus, specific life history models make specific predictions, but it is hard to make statements about the general predictions of life history theory, in the sense described above (Baldini 2015). For this reason, although we discussed some relevant life history models, we would not describe the existence of the BCD as "predicted by life history theory" without further specification.

A second sense of life history theory that one finds is the idea that a broad group of human behaviours covary along a single axis of "slow" to "fast" (e.g., Dunkel & Decker 2010; Dunkel et al. 2014; Figueredo et al. 2007; Giosan 2006). Many of these behaviours have no obvious connection to growth, reproduction, or somatic maintenance, and this sense of "life history theory" does not follow in a simple way from the first sense (described above). Our explanation for the BCD suggests that some of these behaviours might be correlated due to common ecological drivers more than shared biological mechanisms. We also note that the questionnaire scales measuring this putative continuum often conflate potential causes of behaviour with the behavioural responses themselves. For example the "mini-K" scale of the Arizona Life History Battery (http://www.u.arizona.edu/~ajf/pdf/Arizona%20K-Battery.pdf; Figueredo 2007) measures agreement with statements of experience, such as, "While growing up, I had a close and warm relationship with my biological mother," in sum with self-reported behaviours, such as, "I avoid taking risks." Thus, the construct validity and conceptual utility of such scales can be questioned (Copping et al. 2014).

Still a third sense of life history theory is the idea that particular childhood experiences lastingly calibrate adults' behavioural strategies (Ellis et al. 2009; Griskevicius et al. 2011b; Hill et al. 2016). In our explanation for the BCD, we do not exclusively privilege childhood experiences or irreversible developmental plasticity. Our account is compatible with day-to-day ongoing experience of low SES in adulthood playing a large role in the behaviours of the BCD. Thus, we do not wish to identify our account with life history theory in this sense, although our account does not necessarily conflict with it, either. In summary, all three senses of life history theory have potential relevance to our proposed explanation for the BCD, but, given the various uses of the term, to have used it as a descriptor of our account would invite confusion about our precise claims.

R2.3. We didn't claim that the BCD is adaptive, rational, logical, or optimal

Section 8.4 of our target article is titled "The BCD is not necessarily adaptive and perceptions are not necessarily accurate." Nonetheless, many of our commentators used the word "adaptive" in relation to the BCD (**Białek & Reddy**; **Brown & Olding**; **Gassen, Bradshaw, Leyva, & Hill** [**Gassen et al.**]; **Grossmann & Varnum**; **Jones**; **Quinlan**; **Rad & Ginges**; **Rickard**; **Robinson & Piff**). Meanwhile, others used the word "rational" (**Carmel & Leiser**; **Doebel et al.**; **Srivastava & Srinivasan**), assuming that this is what we meant when we wrote that BCD behaviours can be seen as contextually appropriate. However, we actively avoided using such terms as "adaptive," "rational," and "logical" in our target article, because these words have very specific (although sometimes multiple) meanings that we did not wish to evoke.

To say that a behaviour is "adaptive" in the evolutionary sense is to suggest that it maximises Darwinian fitness. As we outlined in the target article (sect. 8.4), it is plausible that the tendency to prioritise more immediate outcomes over delayed ones, given certain environmental contexts, may have been adaptive in ancestral environments. However, any psychological mechanisms we have for making such decisions evolved to deal with cues and cue-world mappings that are potentially different from those faced in contemporary societies. Various features of our current environments may skew perceptions and behaviours away from what is strictly adaptive. Indeed, the commentary by **Lewis & Lewis** gives a more detailed account as to how maladaptive behaviours might arise as a nonfunctional by-product of adaptive mechanisms. The commentary by **Rickard** is also relevant here, as it outlines how the ability to accumulate capital to the advantage of one's descendants is a relatively new phenomenon, meaning that responses to this possibility may not be adaptive in the Darwinian sense.

In our target article we also avoided describing BCD behaviours as "rational," because doing so might imply that the behaviours ought to maximise utility. This assumption of rationality is one that **Carmel & Leiser** accuse us of making; they state, "The 'poor but neoclassical' approach treats poor people as utility-maximizing agents and focuses on the structural constraints that affect decision making as a consequence of reduced opportunities and incomplete information" (para. 1). Carmel & Leiser are close to the truth in saying that we present an evolutionary take on this line of thought. However, we do not assume that people are necessarily operating as utility-maximising agents any more than they are fitness-maximising agents – hence, our description of the BCD as contextually appropriate rather than rational or adaptive.

We also chose to not use the term "logical" to describe the BCD, because, for some, this term can imply a consciously reasoned decision-making process. As we discussed in the target article (sect. 4.1), the BCD may be delivered by reflective or automatic psychological processes. That is, the mechanisms underlying the BCD need not always involve conscious reasoning.

Having discounted the use of the words "adaptive," "rational," and "logical," we were forced to contemplate alternative terms. We decided against the use of the word "optimal," because it provokes thoughts of the sort of fitness- and utility-maximising models that led us to avoid using the words "adaptive" and "rational," and because, to some of our readers, it might imply a value judgement about whether a given behaviour is socially desirable. Left with a somewhat constrained vocabulary, we settled on "contextually appropriate." We hoped this term would convey the idea that BCD behaviours are understandable given the contexts in which they are expressed, without implying that they *necessarily* maximise current fitness or utility, involve conscious reasoning processes, or should be valued differently than other behaviours. The exact entailments of a claim of "contextual appropriateness" are, we admit, rather underspecified, given that it does not necessarily mean utility or fitness maximising in the current environment, nor does it mean consciously thought through. Instead, the notion of contextual appropriateness must ultimately be grounded in the normal functioning of context-dependent psychological mechanisms in response to particular classes of environmental experience (**Lewis & Lewis**). Further theorizing of what exactly contextual appropriateness means is required if, as **Brezina** and Lewis & Lewis suggest, the term is to become a useful explanatory one for social issues.

R3. Genetic confounds and the concept of plasticity

Most of our commentators either broadly supported the ideas presented in our target article or objected to specific facets of our perspective. **Sherlock & Zietsch** challenge our core assumptions more directly. At a conceptual level, they argue that it is invalid to deploy arguments about behaviour being tailored to the environment when explaining differences between individuals of the same species. When comparing species, a mechanism (natural selection on genes) tailors the species' typical behaviour to its typical environment. Within a species, they argue, "There is no *equivalent* process that differentially tailors each *individual* within a species to his or her personal environment" (para. 2; emphasis original). Hence, they argue, there is no reason for thinking that different individuals of the same species that are faced with different environments should be able to behave in contextually appropriate ways.

We are somewhat surprised by this claim. Individuals growing up in Hungary acquire the Hungarian language and become skilled at driving on the right-hand side of the road, whereas individuals growing up in England do not. These are examples of tailoring to the local environment. Many well-understood processes contribute to such tailoring, which is generally referred to as "plasticity." A few obvious examples include tanning, habituation, imprinting, classical conditioning, reinforcement learning, and developmental induction – and this list is not exhaustive. In some cases, the functional design and mechanistic basis of these adaptations have been described in great detail. Of course, their existence is itself the outcome of the deeper Darwinian genetic process that produces differences (including differences in plasticity) between species. Nonetheless, there is no question that they exist and that their function is to differentially tailor individuals to their personal environments. Thus, a plethora of mechanisms

is available by which the behaviour of individuals becomes contextually appropriate to their local environments. Some combination of such mechanisms is, we contend, at least partly responsible for the behaviours of the BCD.

On the empirical side, **Sherlock & Zietsch** point out that much of the evidence we cite is correlational. As such, it could equally well be explained by genetic associations between socioeconomic and psychological variables. We acknowledge that this is a major issue and conceded as much in section 8.5 of the target article. To disentangle genetic correlations from environmental causes is one of the main challenges in this area. Our account requires not that genetics makes no contribution to the association of SES and behaviour but that the causal impact of the environment, via plasticity of some form, makes at least some contribution. We agree that the relative importance of genetic and environmental effects, and their interactions, needs to be established more definitively. We reiterate the conclusion of section 8.5: More experimental research is needed. Ultimately, only the experimental method can definitively evaluate causal claims about environmental factors. As such, we welcome the recent turn towards large-scale randomised-control trials in social science (Duflo & Banerjee 2011), as well as the various ingenious ways psychologists have developed to experimentally manipulate environmental experiences (e.g., Kidd et al. 2013).

R4. Welcome extensions of our ideas

A number of our commentators proposed useful extensions of, or additions to, the ideas we presented in the target article. We are grateful to them for adding their ideas and, in some cases, providing new interpretations of our perspective. In this section, we highlight and discuss these valuable contributions.

R4.1. The BCD as a risk-management strategy

In the target article, we focussed on temporal discounting as a core concept connecting the BCD behaviours, which we suggest are driven by the experience of uncontrollable future-limiting factors. We touched briefly on the concept of risk acceptance (defined as a willingness to accept options associated with variable outcomes over less-variable options of equal expected value), noting that the contextually appropriate response perspective does not, without further assumptions, make *predictions about* this form of risk acceptance. However, as we mentioned in the target article, and as the commentaries of **Jones**; **Mell, Baumard, & André** (**Mell et al.**); and **Amir & Jordan** point out, evidence suggests that preferences for immediate rewards are driven by the inherent uncertainty of future outcomes (Andreoni & Sprenger 2012; Weber & Chapman 2005). That is, temporal discounting is a response to perceived collection risk (Mell et al.).

Amir & Jordan make the excellent suggestion that temporal discounting can be conceptualised as a risk-management strategy by which people respond to uncertainty by becoming more present-oriented. They point out that by conceptualising the BCD as a risk-management strategy, we can more parsimoniously account for behaviours involving temporal trade-offs as well as those involving risk and social preferences. As motivation for risk aversion at lower SES, Amir & Jordan highlight the marked effects of fluctuations in resource availability for those living in deprivation: "small and moderate fluctuations in resources (income, calories, etc.) are unavoidable, but only those at the margins feel the full effects of such fluctuations and, consequently, must be more attentive to variability in their environment and the downside risk of their decisions" (para. 2). Conceptualising the BCD as a risk-management strategy, as Amir & Jordan suggested, results in a more inclusive BCD, thus offering a more comprehensive framework for understanding socioeconomic variation in behaviour (and thereby addressing some of the concerns expressed by commentators regarding the restricted range of behaviours considered in the BCD – see sect. R1.1). For example, it might allow us to accommodate **Robinson & Piff**'s suggestions that prosocial behaviours among lower-SES individuals are a strategy to increase personal control to buffer against external threats.

Conceptualising the BCD as a risk-management strategy also allows us to account for the role of unpredictability, as suggested by **Gassen et al.** and by **Mittal & Griskevicius**. As Gassen et al. point out, both actual control and perceived control are reduced when outcomes are unpredictable, and unpredictability is greater in lower-SES environments. Further, as **Srivastava & Srinivasan** emphasise, lower-SES people more frequently operate close to budgetary boundaries, meaning that unpredictable changes in circumstances have more severe consequences. Nonetheless, as stated by Mittal & Griskevicius, "Harshness and unpredictability might have distinct effects, because the adaptive methods to deal with a consistently harsh environment are different from the methods to deal with a rapidly changing and inconsistent environment" (para. 4). Therefore, more empirical work is needed to establish whether harshness and unpredictability produce distinct effects or whether these are different factors that produce similar-looking consequences. Fortunately, Frankenhuis et al. (2013) have provided a developmental theoretical model suggesting that harshness and unpredictability produce distinct contingency profiles, which offers testable predictions about the maturation of infants under these conditions. Such models provide useful starting points for devising empirical tests and improving our understanding of the effects of different environments.

The commentary by **Mell et al.** also contributes to our understanding of the BCD in terms of risk management. They suggest that although we explained the BCD in terms of the collection risk associated with future rewards, we should also consider the costs of waiting for future rewards, even when the future rewards are guaranteed. They provided some excellent examples of situations in which waiting would not be contextually appropriate, because the costs of waiting would outweigh the rewards of doing so. For example, they present the following thought experiment: "Imagine a farmer who participates in an economic study in which he is offered a choice between receiving $1,000 now or $2,000 in a month. Because this particular farmer does not own any expensive agricultural equipment, he is only able to sow half of his fields simultaneously. However, $1,000 now would allow him to buy new equipment and exploit his whole farm. This would yield him an expected $2,500 increase in revenue by the end of the month. Hence, our farmer

should prefer the smaller-sooner reward, even though the collection risk in our example could be close to zero and the larger reward is only delayed by a month. Instead, the fact that his current level of capital is associated with a particularly high opportunity cost in productivity determines his choice" (para. 4). In this manner, the commentary by Mell et al. gives several clear accounts of ways, other than collection risk, in which economic deprivation may increase the value of more immediate rewards.

On a similar theme, **Sear & Schaffnit** call for an increased focus on the costs and benefits of behaviours in the present. They suggest that "the costs and benefits of behaviours *in the present* differ by environmental context and that it is not just the *size* of the present versus future reward that matters but that the costs and benefits may also be realised in *different currencies* in different environments" (para. 3; emphasis original). Because of this, they emphasise, we cannot always simplistically characterise the decisions that people face as smaller-sooner versus later-larger rewards. Sometimes the payoff in the present is the larger of the two, or it is in a favoured currency, in which case patience *still* does not pay. They illustrated this idea with the example of investment in education. In the target article, we suggested that it is less beneficial for people to invest in education if they are unlikely to reap much reward from it later in life. Sear & Schaffnit add that lower-SES individuals may benefit from leaving school early by gaining immediate earnings and opportunities to acquire other skills, which may be more valuable in their context. In this sense, the additions offered by Sear & Schaffnit tie in with those of **Mell et al.**, who emphasise the effects of opportunity costs.

Collectively, the commentaries reviewed in this section make a compelling case for viewing the BCD as the behavioural result of strategies for managing risks, costs, and benefits under conditions of limited resources, as well as limited control. This perspective is not incompatible with the one we presented in the target article – rather, it is a superordinate explanation, which allows us to parsimoniously account for a broader constellation of behaviours, including those involving temporal trade-offs. As such, it is a welcome extension of the perspective we originally presented, and one that we wish to champion.

R4.2. The physiological constellation of deprivation

In our target article, we suggested that socioeconomic inequalities in life expectancy can be understood as resulting from a combination of differential extrinsic mortality risk and the intrinsic mortality risk it causes via a double disinvestment in behavioural and physiological investments in health. In response, **Garcia & Blackwell** suggest a subtly different perspective on our concept of physiological disinvestment: that "development in a deprived environment may lead to not just *disinvestment* in repair and immune mechanisms but also *investment* into alternate kinds of immune defense and repair" (para. 1; emphasis original). They go on to explain how the increased pro-inflammatory responses associated with experiences of early-life stress "might represent a predictive adaptive response that evolved in ancestral environments in which uncertainty was coupled with greater risks of injury and illness" (para. 2). Garcia & Blackwell explain that this innate, more general, inflammatory response is quicker and cheaper to establish than more specific adaptive (in the immunological sense) responses, which take time to develop. They suggest that the costs and time required to generate a more specific immune response mean that a stronger innate immune response may be preferred when time is short.

In the sense that it is focussed on *differential* investment rather than *dis*investment, **Garcia & Blackwell**'s perspective has something in common with the strengths-based approach suggested by **Frankenhuis & Ellis** (see R4.3 for further discussion). We applaud this suggestion, as it moves thinking away from deficit models and more firmly in the direction of contextually appropriate allocation of resources.

Relatedly, **Brown & Olding** discuss the epigenetic processes that might underlie the behavioural and physiological constellations of deprivation. They propose that the costs and benefits of the various possible contextually appropriate responses to environment are moderated by age and that DNA methylation profiles might act as an epigenetic clock, regulating such responses in line with age.

R4.3. Taking a more strengths-based approach

In our target article, we advocated moving away from purely deficit-based thinking regarding the behavioural effects of deprivation. We emphasised that we view the present-oriented behaviours of the BCD as a contextually appropriate response to structural and ecological factors rather than as a pathology or a failure of willpower. Yet the responses of our commentators suggest to us that, perhaps, we did not go far enough. **Frankenhuis & Ellis** go a step further to promote a strength-based approach, suggesting that "contextually appropriate responses may also include the development of *enhanced skills and abilities* that are ecologically relevant in harsh, unpredictable environments" (para. 2; emphasis original). They explore the potential effects of people's adapting to stressful environments, highlighting that people from unpredictable environments may become better able to shift attention between tasks or to track novel information. They also underscore the implications of taking a fuller perspective that acknowledges the strengths developed by people who have experienced various adversities. They concluded that understanding the enhanced skills and abilities developed in environments of deprivation could allow us to design classroom and work-training environments that work with rather than against the strengths of stress-adapted people.

Related to the call from **Frankenhuis & Ellis** to focus on the strengths developed by people in harsh and unpredictable environments, several commentators emphasise the socially desirable behaviours that are more common in lower-SES communities. For example, **Robinson & Piff** review the prosocial tendencies that are more common among lower-SES individuals, suggesting that "cooperative communities may provide a form of 'collective control' over threatening environments" (para. 9). **Srivastava & Srinivasan** cite the charitable behaviour observed among lower-SES individuals and called for a greater focus on such positive behaviours. Similarly, **Pearson & van der Linden** focus on environmental concern as an example of a socially desirable attitude, which they say is stronger among economically disadvantaged groups (although cf. Gifford & Nilsson 2014). We chose not to focus on these behaviours in our BCD, because they are not so straightforwardly joined by the conceptual threads of low control and temporal discounting as the

other behaviours. However, we certainly do not wish to paint a negative picture regarding those behaviours that are more frequently seen at lower SES, and we agree that it is important to emphasise the socially desirable traits and abilities that are more common in lower-SES people.

R4.4. Early-life learning experiences are beyond control

In our target article, we proposed that limited control over future outcomes should be a driving factor of the BCD. We also outlined some ways in which the effects of early-life adversity can become embedded and amplified through feedback loops (sect. 3.2). However, we did not emphasise the fact that early-life experiences, especially for altricial species, are beyond individual control. This idea is highlighted in the commentary by **Kurkul & Corrieveau**, who discuss how early-learning experiences are beyond individual control and consequently may contribute to the BCD. They describe how lower-SES children have fewer opportunities to engage in new activities that help them acquire information, creating inequalities in conceptual knowledge and information-seeking behaviours, which are then reinforced by feedback loops. As they put it, "A virtuous cycle of learning occurs for children who have access to the type of numerous, rich, and varied experiences that support acquisition of knowledge about the world" (para. 3). They propose that for those who lack access to such rich early-learning opportunities, the potential for later educational success is constrained; as we said in our target article, constraints breed constraints.

R4.5. Additional routes for intergenerational transmission

In section 4.4 of the target article, we briefly touched upon the possible biological mechanisms by which stresses and disadvantages may be passed down through generations. **Rickard** helpfully expands upon this picture in his discussion of the pathways by which various forms of capital may be intergenerationally transmitted. He also explains that the evolutionarily novel complexity of our societies and their varied routes for transmission of capital may mean that behavioural responses to having capital (or lack thereof) are maladaptive – another reason for us to label the BCD as a contextually appropriate response rather than an adaptive one (see section R2.3).

Relatedly, **Białek & Reddy** extend our discussion of the intergenerational transmission of disadvantage through biological mechanisms (sect. 4.4 of the target article) to include what infants learn about the world through their parents. Their commentary lists a number of ways in which patterns of temporal discounting may be transmitted intergenerationally via social learning mechanisms (an intergenerational case of the social learning processes we discussed in sect. 4.3 of the target article).

R5. Welcome considerations of the policy implications of our ideas

In addition to suggesting some excellent extensions to our target article (see sect. R4), our commentators have done an admirable job of drawing out the implications of our perspective for ethics, policy, and practice. We welcome these explorations and take this opportunity to emphasise their key conclusions.

In her commentary on the ethical implications of our perspective for policy making, **Chevallier** notes the inherent bias in social class among policy makers. She stresses that the majority of policy makers originate from high-SES backgrounds and therefore tend to place value on behaviours that would be appropriate within the contexts they have experienced. She uses the example of teen pregnancy, proposing that two key assumptions are often made: "(1) Early pregnancies are not chosen, and women would delay childbearing if provided with adequate family-planning options; and (2) early childbearing is one of the main reasons why many women from poor backgrounds drop out of school, thereby depriving themselves of adequate training and, ultimately, of opportunities to earn decent wages" (para. 4). Chevallier challenges both of these assumptions, providing evidence to suggest that they do not hold: Many young women *choose* to reproduce relatively early, and early childbearing does not meaningfully alter the eventual wage-earning power of women in lower-skilled jobs. Her commentary provides a superb example of how thinking about contextually appropriate responses could help us avoid imposing our own preferences upon others in misguided attempts to encourage them to make "better" choices.

Chevallier's sentiment is echoed in the commentary by **Freese**, who warns of the dangers of viewing a scientific problem from the biased perspective of many policy makers. He argues that, from an evolutionary perspective, it is the behaviour of higher-SES individuals that appears peculiar, and that "we should not treat the behaviors of the affluent as providing the natural baseline from which different behaviors by low-SES people are to be explained" (para. 3). Freese may well be correct in asserting that we should frame our scientific questions from the perspective of trying to explain what he calls a "behavioural constellation of advantage" rather than focusing on lower-SES behaviours. However, we must also acknowledge that the relevance of academic research for the wider world is judged in part by its usefulness in solving policy problems, even if we question whether some of the behaviours that policies aim to prevent should be viewed as problematic.

Perhaps a conclusion we might draw from the commentaries by **Chevallier** and **Freese** is that policy makers should be less paternalistic. However, **Adams**'s interpretation of the implications of our perspective suggests that this would be too simplistic. Adams examines the implications of the contextually appropriate response perspective for public health interventions. She discusses the concept of "low-agency" interventions – schemes that do not rely on recipients' using their own resources to engage with them. She argues that low-agency interventions, such as increasing the financial availability of healthy food, might not actively engage the recipients but can still increase their control over their diets. Adams discusses the common misperception that low-agency interventions curtail individual choice, arguing that they can actually increase individual control – something that our perspective suggests would be beneficial.

Indeed, an interesting case study in our local area, Newcastle upon Tyne, found that neighbourhood renewal efforts (a form of low-agency intervention), including improvements in local housing security and road safety,

led to a sharp decline in smoking among residents (Blackman et al. 2001). As we discussed in our target article (sect. 6), this is one way in which our perspective makes different predictions than other attempts at understanding and modifying health behaviour. While many models presume that smoking-specific campaigns are needed to decrease smoking, our perspective suggests that a more general reduction in uncontrollable mortality risks should increase the incentive for healthy behaviour in all domains. Improved neighbourhood safety may not seem like an immediately obvious way to encourage people to stop smoking or improve their diets, but we predict that meaningful reductions in risks beyond individual control should increase people's incentives to reduce the risks that *are* within their personal control through healthier behaviour.

In his commentary, **Brezina** transfers some of our conclusions about the potential unintended consequences of fear campaigns in public health to the domain of interventions in criminology. In section 6.1 of the target article, we discussed how the contextually appropriate response perspective alters our predictions regarding the effects of fear appeals (campaigns intended to change behaviour by inducing fear of health threats). We suggested that fear appeals might fail to change health behaviour if their recommendations for mitigating specific risks only offer people small risk reductions against high background mortality risk. Brezina translates this logic to the "Scared Straight" programs in the United States, which aim to reduce juvenile offending by highlighting the horrors of prison life. Such programmes have been found to *increase* offending, and Brezina suggests that this result may be because they increase pessimism about the future, thereby eliciting more present-oriented behaviour. His commentary advises that interventions offering optimistic future prospects (providing offenders with a realistic positive alternative to the bleak futures they might otherwise expect) are more successful than their punitive counterparts. We are very pleased to see our perspective translated for those working in criminology and fervently hope that Brezina is correct in his assertion that "CARP [contextually appropriate response perspective] will help us better understand why programs often produce unintended effects – an understanding that could lead to more effective and humane interventions" (para. 8).

R6. Conclusion

In conclusion, many of the commentaries regarding our proposed BCD and its causes and consequences helped us further extend and explain the ideas put forward in the target article. In some cases, commentators seem to have misunderstood our perspective, and their comments offered us the opportunity to make the necessary clarifications and tackle common misperceptions (for example, that the BCD is necessarily adaptive or that we characterise it as a "life history strategy"). In other cases, commentators have extended or modified our ideas in ways that make them more powerful (for example, by suggesting that we conceptualise the BCD as a risk-management strategy or by outlining a potential physiological constellation of deprivation). Other commentators added richness to the picture by discussing additional mechanisms that might underlie the effects of future-limiting factors (or extrinsic risks, if we are to conceptualise the BCD as a risk-management strategy) on BCD behaviours. Finally, some commentators offered valuable discussions of the important potential implications of our ideas for ethics, policy, and practice, raising interesting research questions in the process. We are grateful to have received such comments, as they helped us clarify, expand, modify, enrich, and better understand the implications of our original ideas.

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[The letters "a" and "r" before author's initials stand for target article and response references, respectively]

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