



## Ecological contingencies in women's calorie regulation psychology: A life history approach

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### HIGHLIGHTS

- Experimentally examined effects of harshness on women's calorie regulation.
- As predicted, harshness cues influenced women differently depending on development.
- Women from low SES environments respond by increased desire for food.
- Women from high SES environments respond by decreased desire for food.
- Results provide new insights into women's weight regulation psychology.

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### ABSTRACT

We used insights from life history theory and the critical fat hypothesis to explore how environmental harshness influences women's food and weight regulation psychology. As predicted by our theoretical model, women who grew up in poorer, more unpredictable environments responded to harshness cues in their adult environments by exhibiting a greater desire for food (Studies 1 and 2) and a diminished concern with calorie restriction and weight loss (Study 3). In sharp contrast, women who grew up in more predictable, wealthier environments responded to these cues by exhibiting a diminished desire for food and increased concern with calorie restriction and weight loss. This research provides novel insights into the role that local environmental factors play in women's food and weight regulation psychology.

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### Introduction

It is commonly assumed that women's attitudes toward food and dieting emerge in response to social and cultural pressures that promote specific body types as being "ideal." This view is largely supported by existing research. For example, researchers have demonstrated that viewing images of extremely thin fashion models predicts increased dieting and disordered eating among women (Andersen & DiDomenico, 1992; Knobloch-Westerwick & Crane, 2012; Stice, Mazotti, Krebs, & Martin, 1998; Tiggemann & Pickering, 1996). Others have found that body dissatisfaction and dieting are more common in regions of the world that endorse a very thin female body ideal compared to regions that favor a more substantial female

body size (Chen & Swalm, 1998; Heesacker, Samson, & Shir, 2000; Jager et al., 2002; Mahmud & Crittenden, 2007; Swami et al., 2010).

Although such research supports the commonly held assumption that social and cultural pressures play an important role in shaping women's attitudes toward food and dieting, this explanation is incomplete by itself. First, this view does not account for the fact that many women who are larger than their cultural ideal do not want to lose weight or diet, whereas many thin and normal-weight women do (Huon, 1994; Patton, Johnson-Sabine, Wood, & Mann, 1990; Paxton et al., 1991). Further, this explanation begs the question of where these culturally and socially mediated body ideals come from in the first place. These gaps in our understanding of the nature and origins of women's attitudes toward food and dieting suggest that the processes involved are likely complex, including factors that are social, cultural, and biological. Here, we use insights from life history theory (Ellis, Figueiredo, Brumbach, & Schlomer, 2009; Kaplan & Gangestad, 2005) and the critical fat hypothesis (Frisch, 1985) to examine whether ecological factors that promote the contingent expression of life history strategies influence psychological processes that guide women's food and weight regulation behaviors. By integrating findings from developmental, social, and evolutionary psychology, the current research seeks

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to provide insight into novel environmental factors that may influence women's divergent approaches to food and dieting.

### Life history theory

Life history theory is an evolutionary biological framework used to predict how and when organisms will allocate effort to the various demands of survival and reproduction across the lifespan (Charnov, 1993; Kaplan & Gangestad, 2005; Roff, 1992; Stearns, 1992). Because energy and somatic resources are inherently limited, life history theory posits that organisms face important trade-offs in how they allocate these resources among the several competing demands of life: growth, maintenance, reproduction, and parental care. Importantly, resources that are spent developing one life component cannot be spent simultaneously on another. For example, energy allocated toward immune system functioning cannot be used to concurrently attract a mate. Each organism must therefore 'choose' how to invest these resources in order to further one life component at the expense of others (Ellis et al., 2009; Kaplan & Gangestad, 2005). How and when organisms resolve these tradeoffs constitutes their *life history strategy*.

Organisms have evolved a variety of ecologically-contingent life history strategies that fall on a continuum from fast to slow. Individuals following a faster life history strategy tend to devote fewer resources toward their own development, mature more quickly, and begin reproducing at a relatively early age. Those following a slower life history strategy, on the other hand, invest heavily in their own development, delay sexual maturation, and begin reproducing relatively later in life.

Whether a fast or slow strategy is evolutionarily adaptive depends on features of the organism and their local environment (Belsky, Steinberg, & Draper, 1991; Chisholm, 1993; Del Giudice, 2009; Ellis et al., 2009; Kaplan & Gangestad, 2005; Wilson & Daly, 1997). Theory and research on human life history strategies suggest that people calibrate their strategies based on specific features present in their early childhood environments (Belsky et al., 1991; Kuzawa, McDade, Adair, & Lee, 2010). In particular, early-life environments characterized by high levels of unpredictability and harshness (e.g., low SES, lack of paternal investment) sensitize people to faster life history strategies by speeding up the timing of their physiological and sexual development (Belsky, Houts, & Fearon, 2010; Ellis, 2004; Kuzawa et al., 2010). Because a long lifespan is less certain in harsh and unpredictable ecologies, it is evolutionarily adaptive for organisms to mature rapidly so that they can begin reproducing sooner if ecological conditions remain harsh (Chisholm, 1993; Ellis et al., 2009). Early-life environments that are more benign and predictable, on the other hand, tend to encourage slower life history strategies characterized by delayed physiological and sexual maturation. In these relatively benign environments, it is adaptive for organisms to invest more in somatic effort toward their own development so they are better able to compete for resources and withstand possible ecological fluctuations in adulthood (Ellis et al., 2009; Kaplan & Gangestad, 2005).

Although adults from various backgrounds often behave similarly in benign and non-threatening conditions, in harsh ecologies (i.e., environments characterized by resource scarcity, high rates of extrinsic morbidity/mortality), individuals' behaviors diverge based on differences in their early-childhood environments (Griskevicius, Delton, Robertson, & Tybur, 2011; Griskevicius, Tybur, Delton, & Robertson, 2011; Griskevicius et al., 2013; Hill, DelPriore, Rodeheffer, & Butterfield, under review). This divergence occurs because individuals' developmental histories render them differently able to cope with ecological threats present in their local environments. For those who grew up in more benign environments – and have sufficient stores of embodied and resource capital to effectively manage ecological threats – harsh ecologies promote behaviors consistent with a slower life history strategy (Griskevicius, Delton et al., 2011). This is because individuals able to invest in continued somatic development before reproducing can

improve their ability to survive and compete for resources in harsh ecologies by doing so (e.g., investment in increased bodily robustness in case of famine, furthering one's education to render them better able to compete for resources in a tough economy; Ellis et al., 2009).

For individuals who grew up in relatively resource- and investment-deprived conditions, however, heavier somatic investment in the face of increasing poverty or violence is often suboptimal or impossible in light of their developmental history. These individuals typically lack the stored somatic and resource capital necessary to improve their survivability in such conditions, making them more prone to morbidity-mortality in these types of environments (see Ellis et al., 2009; Kuzawa, 2005, 2008; West-Eberhard, 2003). Harsh ecologies thus promote behaviors consistent with a faster life history strategy to minimize the risk of perishing without having first reproduced.

A growing body of experimental research has found support for harsh ecological conditions eliciting developmentally-contingent life history strategies. For example, Griskevicius, Delton et al. (2011) demonstrated that in benign conditions, people reported similar reproductive timing preferences, regardless of their childhood background. However, mortality cues produced divergent reproductive timing preferences based on differences in childhood SES. Across three experiments, they found that people raised in lower SES environments reported wanting to have children sooner (consistent with a faster life history strategy) in response to mortality risk cues. Conversely, these same cues led those from higher SES backgrounds to report wanting to delay reproduction (consistent with a slower life history strategy). Similar effects have been found with respect to prioritizing immediate versus delayed monetary gains and immediate versus delayed gratification (Griskevicius, Tybur et al., 2011; Griskevicius et al., 2013), shifts that are also consistent with adjustments in life history strategies.

### Critical fat and life history strategies

Is it possible that cues that promote the contingent expression of faster and slower life history strategies may play a role in women's approaches to food and dieting? Because women's appearance and body shape play an important role in mate attraction, one possibility is that cues promoting faster life history strategies – which emphasize more immediate reproduction – would lead women to engage in behaviors aimed at weight loss and fat restriction. Indeed, thin women are seen as more attractive than heavier women in Western culture (Swami, 2006; Weeden & Sabini, 2005; Wilson, Tripp, & Boland, 2005). However, from an evolutionary life history perspective, it is also possible that cues that promote more immediate reproduction may prompt behaviors that promote fat accumulation. This is because female body fat plays a key role in women's fertility regulation – a critical component of life history strategies.

Because women historically needed a minimum store of body fat to ensure their ability to supply a newborn with an uninterrupted supply of calories, women require adipose tissue to make up about 22% of their body weight to maintain ovulation and successfully reproduce (*the critical fat hypothesis*: Frisch, 1976, 1985). When body fat falls below this threshold, estrogen synthesis slows and fertility is suppressed as a means of preventing pregnancy when women lack sufficient fat stores to bear and nurse offspring (Frisch, 1976, 1985, 2002). Once women accumulate enough fat to provide a continuous supply of energy to a developing offspring, fertility is then restored. Indeed, women who are close to this threshold (female athletes, for example) can suppress and restore fertility by losing or gaining only a few pounds, respectively (Frisch, 2002).

Guided by the logic of the critical fat hypothesis, researchers have proposed that women may adjust their body fat as a means of regulating their reproductive capacity in response to changing ecological conditions (*the reproductive suppression hypothesis*: Becker, Breedlove, & Crews, 1993; Condit, 1990; Frisch, 1976; Salmon, Crawford, Dane, &

Zuberbier, 2008; Surbey, 1987; Voland & Voland, 1989; Wasser & Barash, 1983; Williams & Dickson, 2002). This framework predicts that when ecological conditions favor faster life history strategies, women should experience psychological and behavioral shifts that promote body fat accumulation. Conversely, when ecological conditions favor slower life history strategies, women are predicted to experience psychological and behavioral shifts that promote body fat restriction (Becker et al., 1993; Frisch, 1985; Rippon, Nash, Myburgh, & Noakes, 1988; Wasser & Barash, 1983; Williams & Dickson, 2002). Thus, although it is possible that cues promoting faster life history strategies may prompt changes promoting weight restriction, the critical fat and reproductive suppression hypothesis predict the opposite, particularly in light of the very low body weight favored by women in the United States (e.g., Swami et al., 2010).

Here, we sought to experimentally examine this possibility, testing the effect of harsh ecological conditions on women's calorie regulation psychology. Our approach predicts that harsh ecological conditions should influence women's perceptions of desirable food items (Study 1), desire for food (Study 2), and attitudes toward dieting and weight gain (Study 3) in ways that promote their ecologically-continent life history strategies. Two of the most established markers of childhood life history strategy sensitization are parental investment quality and childhood SES (see e.g., Ellis et al., 2009; Griskevicius, Delton et al., 2011). Accordingly, we predicted that for women sensitized to a faster life history strategy in childhood — as indexed by lower quality parental investment or low SES — exposure to cues of ecological harshness will produce psychological shifts that promote calorie consumption. Conversely, for women growing up in childhood environments with higher SES or higher quality paternal care, we predicted that these cues would produce changes that encourage calorie restriction. Moreover, because men cannot regulate their life history strategies by adjusting body fat, we predicted that these effects would be specific to women. This research aims to provide insights into novel processes that influence women's calorie and weight regulation and to lay the groundwork for a deeper understanding of women's relationships with food and dieting.

## Study 1

The purpose of our first study was to examine the relationship between cues to ecological harshness (primed via cues of heightened mortality risk), developmental history, and men's and women's perceptions of a desirable food item. Research indicates that desiring an object (e.g., money) makes the object loom larger in one's memory (Bruner & Goodman, 1947; Zhou, Vohs, & Baumeister, 2009). We therefore sought to examine whether ecological harshness would cause women to experience perceptual distortions in the remembered size of a tasty food item — a chocolate chip cookie — that they viewed earlier in the testing session. We predicted that priming cues to heightened ecological harshness: (a) would lead women from more stressful childhood environments to remember the cookie as being significantly larger than those in the control condition, (b) would lead women from less stressful environments to remember the cookie as being significantly smaller than those in the control condition, and (c) that this pattern of results would not emerge for men because men's fertility is not dependent upon their ability to maintain a critical level of body fat.

## Method

### Participants

One hundred and fifty university students (70 female) served as participants in this study (76 in the harshness condition) in exchange for course credit. Participants' ages ranged from 18 to 25 years ( $M_{age} = 19.21$ ,  $SD = 1.02$ ).

### Design and procedure

Participants came into the research laboratory in small groups and were seated at individually partitioned computer terminals. They were randomly assigned to read a news article describing a sharp increase in the homicide rate (harshness condition) or an article about increasingly strict academic standards being adopted by local universities (control condition). Next, to disguise the true purpose of our experiment, participants viewed a series of photographs of objects (e.g., book, lead weight) and were asked to make various judgments about them (e.g., number of pages in a book). The last of these stimuli was a photograph of a chocolate chip cookie (target stimulus) which appeared for 20 s. After this time had elapsed, the computer directed participants to use the colored pencils and paper located at their terminal to reproduce the last image that they had viewed from memory. Participants were instructed to be as detailed and accurate as possible in the size, shape, and texture of their drawing.

After participants finished the drawing task, they then answered questions about themselves (e.g., sex, age, developmental history), followed by a question about how hungry they were. This latter measure was included to provide a validity check on our dependent variable. If — as we have hypothesized — the remembered size of the cookie reflects participants' desire to consume it, this measure should be positively related to participant hunger. We did not anticipate that hunger, itself, would change in response to the prime because research indicates that when people modulate their food consumption in response to social factors, these behaviors are not regulated by changes in physical hunger. Instead, they are regulated by processes that encourage or inhibit food consumption beyond what would be predicted by physical hunger (e.g., boredom: Koball, Meers, Storfer-Isser, Domoff, & Musher-Eizenman, 2012, stress: Abraham & Beumont, 1982; Arnow, Kenardy, & Agras, 1992; Heatherton & Baumeister, 1991; Herman & Polivy, 1975; Lingswiler, Crowther, & Stephens, 1989; Ruderman, 1985). A suspicion probe revealed that no participants guessed the nature of the experiment.

### Ecological harshness manipulation

To activate cues to ecological harshness, we used a priming methodology adapted from Griskevicius, Delton et al. (2011). Participants read a news article ostensibly from the *New York Times* about escalating levels of violent crime and homicide. The article described how recent years have been marked by a dramatic rise in random acts of violence and homicide in seemingly safe areas. In the control condition, participants read an article about increasingly stringent academic standards being adopted by universities in the area. This article was chosen because it is unpleasant, but does not contain any cues suggesting increasing ecological harshness (e.g., mortality).

To ensure that the articles primed the intended ecological factors, we conducted a pre-test with a separate sample of 60 undergraduates (21 men;  $M_{age} = 19.48$  years,  $SD = 3.13$ ). After reading either the harshness or the control article, participants indicated to what extent the article made them believe that the world is: (a) a dangerous place and (b) becoming more violent. Participants also indicated the degree to which the article made them feel (c) emotionally aroused, (d) uncertain, and (e) upset. Responses were provided on 7-point scales with endpoints 1 (*not at all*) and 7 (*very much*).

As expected, participants in the harshness condition reported believing that the world is a more dangerous place [ $M_{Harshness} = 4.24$ ,  $SD = 1.60$ ;  $M_{Control} = 2.29$ ,  $SD = 1.55$ ;  $F(1, 58) = 23.02$ ,  $p < .001$ ,  $d = 1.24$ ] and that the world is becoming more violent [ $M_{Harshness} = 4.48$ ,  $SD = 1.66$ ;  $M_{Control} = 1.74$ ,  $SD = 1.24$ ;  $F(1, 58) = 52.99$ ,  $p < .001$ ,  $d = 1.87$ ]. However, the two articles did not differ in the amount of emotional arousal [ $M_{Harshness} = 3.68$ ,  $SD = 1.77$ ;  $M_{Control} = 3.06$ ,  $SD = 1.97$ ;  $F(1, 58) = 1.66$ ,  $p = .20$ ], uncertainty [ $M_{Harshness} = 3.52$ ,  $SD = 1.68$ ;  $M_{Control} = 3.74$ ,  $SD = 1.73$ ;  $F(1, 58) = .26$ ,  $p = .61$ ], or upset [ $M_{Harshness} = 3.52$ ,  $SD = 2.01$ ;  $M_{Control} = 3.90$ ,  $SD = 1.58$ ;  $F(1, 58) = .69$ ,  $p = .41$ ] that they elicited.

### Food perception

The diameter (in millimeters) of participants' cookie drawings were independently measured by two trained research assistants blind to the nature of the research hypothesis. The assistants were instructed to measure each drawing at its widest point, resulting in a high degree of inter-rater reliability ( $\alpha = .98$ ). These two measurements were therefore averaged together to create our dependent measure.

### Life history stressors in childhood environment

We measured the presence of stressors in participants' childhood environment by asking men and women to indicate their agreement with the following statements: (a) "My family had significant financial struggles growing up," (b) "My father wasn't very involved in my life growing up," (c) "I have a great relationship with my dad" (reverse scored), and (d) "I've been through a lot of difficult times in my childhood." These items were chosen because research indicates that both economic uncertainty and quality of paternal care play a role in influencing life history strategies (Belsky et al., 1991; Ellis et al., 2009). All ratings were made on 7-point scales (endpoints: 1 = strongly disagree, 7 = strongly agree). These scores were averaged to form a composite measure of childhood environmental stress ( $\alpha = .81$ ).

### Hunger

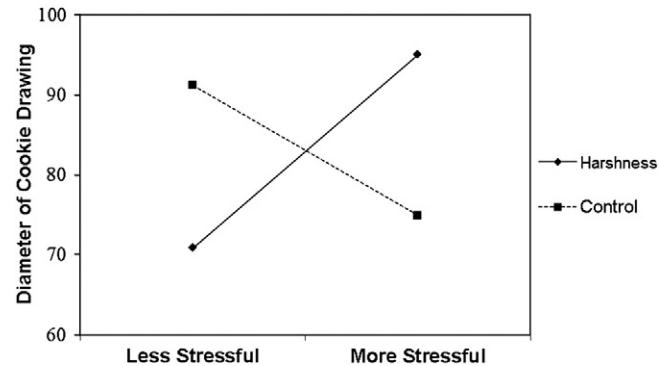
Participant hunger was measured by asking participants to indicate how hungry they were on a 7-point rating scale (endpoints: 1 = not at all hungry, 7 = very hungry).

### Results

Before building our primary statistical model, we first conducted a multivariate analysis of variance (MANOVA) to ensure that priming condition did not influence participants' reported hunger or their recall of stressors present in their childhood environment. Results revealed that priming condition did not influence either of these measures [hunger:  $F(1, 148) = .28, p = .60$ ; childhood stressors:  $F(1, 148) = .03, p = .87$ ]. We then used multiple regression to conduct a second preliminary analysis to ensure that hunger did not change in response to an interaction between the priming condition and developmental stress. In this model, condition (dummy-coded) and developmental stress (centered) were entered as predictors in the first step, followed by the two-way interaction between these variables in the second step (see Aiken & West, 1991). As expected, this result revealed no main effect of condition ( $p = .62$ ) or developmental stress ( $p = .49$ ), or an interaction between the two ( $p = .83$ ) on participant hunger.

Next, we ran a validity check on our dependent measure by testing whether participant hunger was predictive of the size of their cookie drawings. As expected, results revealed a significant main effect of hunger on the diameter of participants' cookie drawings. As participant hunger increased, so too did the diameter of their cookie drawings,  $\beta = .19 (SE = .75), t(1, 149) = 2.34, p = .02$ .<sup>1</sup> This result supported the validity of our dependent measure as being reflective of participants' desire for food and indicated that we would need to control for hunger in our main statistical model.

We next tested the effects of sex, priming condition, and developmental stress on participants' memories for the size of the chocolate chip cookie using a multiple regression model similar in form to that described above. Sex (dummy-coded), condition (dummy-coded), and developmental stress (centered) were entered simultaneously as predictors in



**Fig. 1.** Size (in millimeters) of food drawings completed by participants as a function of condition (harshness vs. control) and childhood environmental stress (Study 1).

the first step, followed by all two-way interactions in the second step, and the three-way interaction between each of the predictors in the third step. Participant hunger (centered) was also included in the first step as a covariate to control for its effect on our dependent measure. The results of this analysis revealed a significant main effect of sex in the first step,  $\beta = -.17 (SE = 2.84), t(4, 141) = -2.08, p = .04$ , as well as a three-way interaction between sex, condition, and childhood environment on the remembered size of the cookie in the third step,  $\beta = .29 (SE = 5.17), t(8, 141) = 1.83, p = .06$ .

To probe this interaction, we next explored the effects of priming condition and childhood environment on perceived cookie size separately for men and women using regression models of the same form. For men, results revealed no main effects or interactions between condition and childhood environment on the diameter of their drawings ( $ps \geq .57$ ). For women, however, the analysis revealed a significant interaction between condition and childhood environment on this measure,  $\beta = -.48 (SE = 3.45), t(4, 65) = -2.71, p = .009$ . Simple slope tests (Cohen, Cohen, West, & Aiken, 2003) revealed that for participants in the harshness condition, developmental stress was positively related to the diameter of their cookie drawings,  $\beta = .40 (SE = 2.48), t(4, 65) = 2.25, p = .03$ . No such relationship was present for those in the control condition, however ( $p = .23$ ). Examining the effects of harshness (vs. control) cues at 1 SD above and below the mean on developmental stress revealed that ecological harshness cues led women from more stressful childhood environments (+1 SD) to remember the cookie as being larger than comparable women in the control condition,  $\beta = -.33 (SE = 5.39), t(4, 65) = -1.94, p = .057$ . In sharp contrast, these same cues led women from less stressful environments (-1 SD) to remember the cookie as being smaller than comparable women in the control condition,  $\beta = .33 (SE = 5.44), t(4, 65) = 1.96, p = .055$  (see Fig. 1).<sup>2</sup>

<sup>1</sup> An analysis was also conducted to test whether participants' hunger interacted with sex, childhood environment, or priming condition on their perceptions of the size of the cookie. To this end, we created a multiple regression model wherein sex (dummy-coded), priming condition (dummy-coded), childhood environment (centered), and hunger (centered) were entered simultaneously as predictors in the first step, followed by all two-way interactions in the second step, three-way interactions in the third step, and the four-way interaction in the fourth step. The results of this model revealed no significant four-way interaction between these variables ( $p = .61$ ).

<sup>2</sup> We also conducted our analyses without including hunger as a covariate. For men, the results remained non-significant ( $ps \geq .65$ ). For women, this analysis revealed a significant interaction between condition and childhood environment on the diameter of participants' cookie drawings,  $\beta = -.40 (SE = 3.62), t(3, 66) = -2.23, p = .03$ . Similar to what was observed in our primary statistical model, simple slope tests revealed that for women in the harshness condition, developmental stress was positively related to the size that they remembered the cookie, although this failed to reach conventional levels of significance,  $\beta = .20 (SE = 2.70), t(3, 66) = 1.70, p = .09$ . Examining the effects of harshness (vs. control) at 1 SD above and below the mean on developmental stress also yielded a pattern of results similar to that found in our primary statistical model (i.e., the model that included hunger as a covariate), however these results also failed to reach conventional levels of significance [+1 SD:  $\beta = -.27 (SE = 5.71), t(3, 66) = -1.58, p = .12$ , [-1 SD:  $\beta = .27 (SE = 5.76), t(3, 66) = 1.60, p = .11$ ]. Although the simple effects in these follow-up analyses did not meet conventional levels of significance when hunger was removed from the model, all four followed the same pattern observed in the primary model. Moreover, because the logic of our hypothesis was that ecological harshness cues would influence women's desire for food beyond what would be predicted by their physical hunger, the model that included the covariate is the most appropriate test of the proposed research hypothesis.

## Discussion

The results of Study 1 demonstrated that exposure to cues of ecological harshness influenced participants' perceptions of a desirable food item. Consistent with life history theory and the critical fat hypothesis, the effects of these cues were specific to women and contingent upon their developmental history. Bearing on the former, results revealed that men's perceptions of the cookie were not influenced by cues to ecological harshness, developmental history, or an interaction between the two. These results are consistent with previous research (Hill et al., under review) and suggest that harsh ecological conditions may not influence men's desire for food in the same way that they influence women's.

For women, however, we found that the effects of ecological harshness on participants' food perceptions varied in ways predicted by theory and research on the contingent expression of life history strategies (e.g., Griskevicius, Delton et al., 2011; Griskevicius, Tybur et al., 2011; Griskevicius et al., 2013). Although some of the simple effects did not meet conventional levels of significance ( $p < .05$ ), the overall pattern of results was consistent with our hypothesis. For women whose developmental histories favor more immediate reproduction in harsh ecologies, primed harshness cues produced a perceptual shift that led them to remember a desirable food item – a chocolate chip cookie – as being significantly larger than what was remembered by women in the control condition. Conversely, for women whose development favors delayed reproduction in harsh ecologies, these cues led women to remember the cookie as being significantly smaller compared to the control group. Moreover, although these perceptual distortions were found to be predicted by participant hunger – which itself predicts desire for food – they were found to influence participants' perceptions of the food item beyond what could be accounted for by hunger. Taken together, the results of Study 1 suggest that women's food regulation psychology may be influenced in important ways by ecological conditions promoting the contingent expression of faster and slower life history strategies.

## Study 2

In Study 2, we sought to test whether we could conceptually replicate the results from Study 1 using a different priming methodology and a more specific measure of developmental stress. Additionally, rather than measuring participants' desire for food indirectly via perceptual distortions of food items, we measured it directly by observing how many free snack items they took when leaving the laboratory. We predicted that we would replicate the pattern of results found in Study 1, demonstrating that harshness cues would influence women's desire for food differently based on their childhood environments. Because the logic of the critical fat hypothesis (Frisch, 1985) is specific to women and Study 1 suggests that men's psychological reactions to food are not affected by ecological harshness in the same manner as are women's, we focus solely on women for the remainder of the paper.

## Method

### Participants

Fifty-four female university students served as participants in this study (28 in the harshness condition) in exchange for course credit. Participants' ages ranged from 18 to 24 years ( $M_{age} = 19.24, SD = 1.45$ ).

### Design and procedure

Participants came into the laboratory one at a time and were told that they would be participating in a consumer research study. Next, they were shown one of two captioned slideshows. One slideshow was designed to prime ecological harshness; the other was designed to be a comparably stressful control. After viewing the slideshow and answering questions to help reinforce the cover story, participants

responded to a series of questions about themselves, including items measuring developmental stress.

After completing the questionnaires (and as participants were getting ready to exit the laboratory), a condition-blind research assistant<sup>3</sup> approached each participant with two bags of snack foods (pretzels and chocolate chip cookies). Participants were told that these items were being offered as a thank you for their participation and that they could take either or both with them when they left. After participants left the room, the research assistant then recorded which (if any) snack foods were taken using the participant's ID number. A suspicion probe revealed that none of the participants knew the true purpose of the experiment.

### Ecological harshness manipulation

We primed ecological harshness via a slideshow that ostensibly summarized a recent news story about escalating levels of violent crime. This slideshow included captioned photos of violent crime scenes, people holding weapons, and images taken from news coverage of recent school shootings in the U.S. In the control condition, participants viewed a slideshow summarizing an article about increasingly strict standards being adopted at local universities. This presentation included captioned photos of people studying, papers with Fs on them, and professors next to chalkboards covered with complicated mathematical formulas. These slides were selected for the control condition because they were expected to produce similar levels of psychological arousal and uncertainty as the harshness prime. Participants in both conditions viewed each slide for 15 s.

A pre-test was conducted to confirm that the harshness slideshow led participants to believe that the world is more dangerous than the control slideshow. We also wanted to ensure that the two primes did not differ in the amount of emotional arousal and uncertainty that they evoked. To this end, a separate sample of fifty-eight college students were randomly assigned to view one of the slideshows (33 viewed the harshness slideshow). Next, participants answered the following questions on a scale ranging from 1 (*not at all*) to 7 (*very much*): How much did this slideshow make you feel that (a) the world is becoming more violent and (b) that you are at risk of being the victim of a violent crime? Participants were also asked to use rating scales of the same form to indicate how much the slideshow made them feel (c) emotionally aroused and (d) uncertain about the future.

Compared to participants who viewed the academic slideshow, those who viewed the harshness slideshow reported believing that the world is becoming more violent [ $M_{Harshness} = 5.21, SD = 1.80; M_{Control} = 2.16, SD = 1.18; F(1, 54) = 46.82, p < .001, d = 2.00$ ] and that they are more likely to be the victim of a violent crime [ $M_{Harshness} = 5.27, SD = 1.65; M_{Control} = 2.04, SD = 1.27; F(1, 54) = 60.45, p < .001, d = 2.19$ ]. However, the two slideshows did not differ in the extent to which they elicited emotional arousal or uncertainty ( $Fs \leq .10, ps \geq .75$ ). Thus, the mortality slideshow led participants to perceive their environment as being harsher than the control slides, but the two primes did not evoke differing levels of arousal or uncertainty.

### Life history stressors in childhood environment

We measured life history stressors present in childhood by asking participants to indicate their agreement with the following five items on 7-point scales (anchors: 1 = *strongly disagree*, 7 = *strongly agree*): (a) "My parents had significant financial struggles while I was growing up," (b) "There were times in childhood when I went to bed hungry," (c) "There were times in my childhood when I qualified for reduced cost or free lunch at school," (d) "There were times in my childhood when my family received financial assistance (e.g., welfare, food stamps, etc.) to help make ends meet," and (e) "My family had enough money for things growing up" (reverse scored). Responses on these

<sup>3</sup> All research assistants were female.

items were averaged to form a composite measure of life history stressors encountered in childhood ( $\alpha = .89$ ). These items provide an objective measure of developmental stress (e.g., one's definition of what it means to have gone through hard times is open to interpretation) and are consistent with research precedent (e.g., Griskevicius, Tybur et al., 2011).

## Results

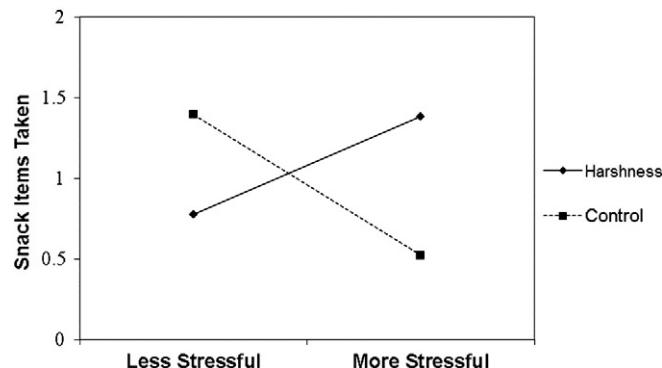
To ensure that participants' recall of their childhood environments was not influenced by the priming procedure, we first conducted a univariate ANOVA with priming condition as the between-subjects factor. Results revealed that recall of childhood stress was not influenced by priming condition,  $F(1, 53) = .36, p = .55$ . Next, we summed the number of snack items taken by participants (range: 0–2) and normalized these scores using a square root transformation to prevent violation of the normality assumption of our statistical model (see e.g., Tabachnick & Fidell, 2001). We then entered this score as the dependent measure in a multiple regression model. Condition (dummy-coded) and developmental stress (centered) were entered simultaneously as predictors in the first step, followed by the two-way interaction in the second step.<sup>4</sup>

Results revealed a significant interaction between condition and developmental stress on the number of snack items taken,  $\beta = -.55$  ( $SE = .13$ ),  $t(3, 51) = -3.35, p = .02$ . Simple slope tests revealed that for women in the harsh ecology condition, growing up in a more stressful environment was predictive of taking more food items when leaving the laboratory,  $\beta = .33$  ( $SE = .09$ ),  $t(3, 51) = 2.01, p = .05$ . The opposite effect was found for women in the control condition, with developmental stress being marginally predictive of taking fewer food items,  $\beta = -.40$  ( $SE = .12$ ),  $t(3, 51) = -1.90, p = .06$ . Examining the effects of harshness (vs. the control) at 1 SD above and below the mean on developmental stress revealed that the pattern of this interaction was similar to that found in Study 1. For women growing up in more stressful environments (+1 SD), harshness cues increased the number of snacks taken when departing the laboratory,  $\beta = -.52$  ( $SE = .20$ ),  $t(3, 51) = -2.90, p = .006$ . For women growing up in less stressful environments (-1 SD), harshness cues decreased the number of snacks taken,  $\beta = .30$  ( $SE = .19$ ),  $t(3, 51) = 1.74, p = .088$  (see Fig. 2), although this effect did not reach statistical significance.

## Discussion

Despite varying the way that ecological harshness was manipulated and the items we used to measure developmental stress, Study 2 again revealed that primed ecological harshness cues produced changes in women's food regulation psychology. Specifically, for women growing up in more stressful environments, exposure to cues indicating a harsh ecology increased desire for food. These women took more snacks with them at the end of the testing session compared to similar women in the control group. In contrast, these same cues led women from less stressful environments to take fewer snacks with them at the end of the testing session compared to similar women in the control condition. Taken together with the results of Study 1, these findings suggest that ecological cues promoting the contingent expression of life history strategies may influence women's calorie regulation psychology in different ways depending on their developmental history.

<sup>4</sup> Because hunger was found to be correlated with our dependent measure in Study 1, participant hunger was again measured in Study 2 so that we could control for it if necessary. Regression analyses revealed that hunger was not related to the number of food items participants took with them as they left the laboratory ( $p = .47$ ) and was therefore not included as a covariate in our statistical model.



**Fig. 2.** Number of free snack items taken by participants as a function of condition (harshness vs. control) and developmental history (Study 2). Dependent measure reflects scores following square root transformation.

## Study 3

The first two experiments examined whether cues to ecological harshness have implications for women's desire for food. However, given that fat loss and accumulation are processes that occur over time, our theoretical framework predicts that these cues should also have implications for attitudes governing food and weight regulation over longer periods. Study 3 was therefore designed to test the prediction that, in addition to impacting women's desire for food (as indexed by food size perceptions and the number of food items taken), harshness cues would also influence women's global attitudes toward dieting and weight loss in similar ways. For women sensitized to a faster life history strategy in childhood, we predicted that harsh ecologies would increase endorsement of attitudes that promote calorie consumption and weight accumulation – shifts that would have historically facilitated a faster life history strategy. Conversely, for women sensitized to a slower life history strategy in childhood, we predicted that these cues would increase endorsement of attitudes that promote calorie restriction and weight loss – shifts facilitating a slower life history strategy.

The second goal of Study 3 was to explore whether a woman's BMI moderates the predicted effects. Because a woman's existing body fat plays a key role in influencing attitudes toward dieting and weight loss, we measured women's BMI to examine whether it would moderate our results in theoretically meaningful ways. In particular, we wanted to determine whether our results were driven by women with existing levels of body fat that are sub-optimal for their given life history strategy (i.e., lower body weight for fast strategists and higher body weight for slow strategists).

## Method

### Participants

Sixty-two female university students served as participants in this study (31 in the harshness condition) in exchange for course credit. Participants' ages ranged from 17 to 23 years ( $M_{age} = 19.00, SD = 1.33$ ).

### Design and procedure

The design and procedure for Study 3 were the same as Study 1 except that after reading each article, participants responded to items assessing their beliefs about calorie restriction and their desire to prevent weight gain. Childhood life history stressors were measured using the items used in Study 2. Finally, we asked participants to respond to some questions about themselves (including their height and weight) before they were dismissed.

### Attitudes toward dieting

We measured dieting attitudes by asking women to indicate their agreement with the following four statements on 7-point scales

[anchors: 1 (*strongly disagree*), 7 (*strongly agree*)]: (a) It's a good idea to limit the number of calories you eat in a day to prevent weight gain, (b) It's a good idea to limit the number of calories you eat in a day to prevent overeating, (c) It's a good idea to be aware of the calorie content in food so that you don't eat too many calories, and (d) I like to be aware of the calorie content in the food that I eat. These ratings were averaged to form a dieting attitude composite ( $\alpha = .90$ ).

#### Desire to prevent weight gain

We measured desire to prevent weight gain by having participants rate their agreement with the following four statements on 7-point scales [anchors: 1 (*strongly disagree*), 7 (*strongly agree*)]: (a) I do not wish to gain weight, (b) If I found out that I put on a few pounds since the last time I weighed myself, that would upset me, (c) I am terrified of gaining weight, and (d) I am preoccupied by the desire to be thinner. These scores were then averaged to form a composite measure of desire to prevent weight gain ( $\alpha = .85$ ).

#### Body mass index (BMI)

We calculated participants' BMI per convention using the following equation: Weight (lbs) / [Height (in)  $\times$  Height (in)]  $\times$  703. Participant BMI ( $M = 21.71$ ,  $SD = 2.60$ ).

#### Results

We first tested whether participants' recall of childhood stress was influenced by the priming procedure using a univariate ANOVA, with condition as the between-subjects factor. Results revealed that priming condition had no effect on recall of childhood stress,  $F(1, 60) = .26$ ,  $p = .62$ . Next, to ensure that participants' attitudes toward dieting and their desire to prevent fat accumulation reflect two distinct psychological processes, a principal components analysis was performed using Varimax rotation. The results yielded two distinct factors with eigenvalues above 1.0 (4.82 and 1.03), a distinction verified upon inspection of the scree plot. The first rotated factor consisted of the four dieting measures (accounting for 38% of item variance). The second rotated factor consisted of the four fat prevention measures (accounting for 35% of item variance). These results empirically verified that each of our measures were distinct psychological constructs.

Next, we used multiple regression to test our predictions about the effects of harshness cues, developmental stress, and BMI<sup>5</sup> on women's attitudes toward dieting and their desire to prevent weight gain. In each model, condition (dummy-coded), developmental stress (centered), and BMI (centered) were entered simultaneously as predictors in the first step, followed by the two-way interactions between each of these variables in the second step, and the three-way interaction in the third step.

#### Attitudes toward dieting

The results of our first model revealed the predicted two-way interaction between condition and developmental stress on participants' dieting attitudes [ $\beta = .57$  ( $SE = .49$ ),  $t(6, 54) = 2.30$ ,  $p = .03$ ], as well as a significant three-way interaction between condition, developmental stress, and BMI [ $\beta = -.94$  ( $SE = .21$ ),  $t(7, 53) = -2.11$ ,  $p = .04$ ].

We first probed the two-way interaction between condition and developmental stress on women's attitudes toward dieting while controlling for the effect of participant BMI. Simple slope tests revealed that for participants in the harsh ecology condition, having more stressors present in childhood was predictive of more negative attitudes toward dieting,  $\beta = -.51$  ( $SE = .35$ ),  $t(4, 56) = -2.36$ ,  $p = .02$ . No such relationship was present for women in the control condition ( $p = .30$ ). Furthermore, examining the effects of harshness (vs. control) cues on women's dieting attitudes at 1 SD above and below the mean on childhood stress revealed an interaction pattern similar to that found in the previous two experiments. For women

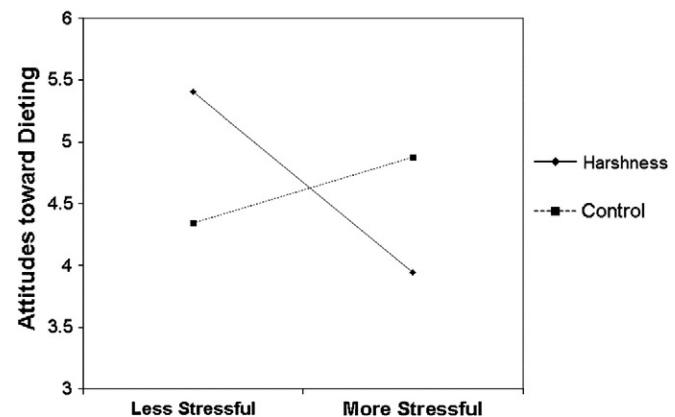
growing up in stressful environments (+1 SD), harshness cues decreased positivity toward dieting relative to the control condition,  $\beta = .32$  ( $SE = .50$ ),  $t(4, 56) = 1.81$ ,  $p = .07$ . Conversely, for women growing up in less stressful environments (-1 SD), these cues increased positivity toward dieting,  $\beta = -.38$  ( $SE = .51$ ),  $t(4, 56) = -2.04$ ,  $p = .05$  (see Fig. 3).

Next, we probed the three-way interaction between condition, developmental stress, and BMI on dieting attitudes by examining the separate effects of developmental stress and BMI within each testing condition. Results for women in the control condition revealed neither a main effect of BMI nor an interaction between this variable and developmental stress on dieting attitudes ( $ps \geq .32$ ). For participants in the harshness condition, however, results revealed a significant interaction between BMI and developmental stress on women's dieting attitudes,  $\beta = .41$  ( $SE = .18$ ),  $t(3, 26) = 2.16$ ,  $p = .04$ . Probing this interaction revealed that for women growing up in less stressful environments (1 SD below the mean), there was no effect of BMI on attitudes toward dieting,  $p = .34$ . For women growing up in more stressful environments (1 SD above the mean), however, lower BMI predicted more negative attitudes toward dieting,  $\beta = 1.04$  ( $SE = .22$ ),  $t(3, 26) = 2.53$ ,  $p = .02$ .

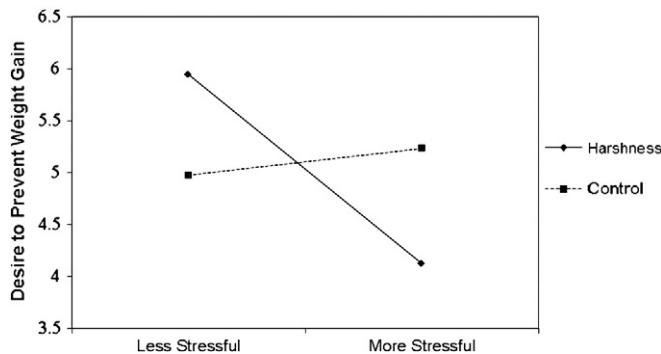
#### Desire to prevent weight gain

As with dieting attitudes, the results of our first model revealed the predicted two-way interaction between condition and developmental stress on participants' desire to prevent weight gain [ $\beta = .60$  ( $SE = .51$ ),  $t(6, 54) = 2.46$ ,  $p = .02$ ], as well as a significant three-way interaction between condition, developmental stress, and BMI [ $\beta = -.87$  ( $SE = .22$ ),  $t(7, 53) = -2.00$ ,  $p = .05$ ].

We first probed the two-way interaction between condition and developmental stress on women's desire to prevent weight gain while controlling for the effect of participant BMI. Simple slope tests revealed that for participants in the harshness condition, having fewer stressors present in one's childhood environment was predictive of a greater desire to prevent weight gain,  $\beta = -.63$  ( $SE = .36$ ),  $t(4, 56) = -2.98$ ,  $p = .02$ . No such relationship was present for participants in the control condition ( $p = .57$ ). Furthermore, examining the effects of harshness on women's desire to prevent weight gain at 1 SD above and below the mean on childhood stress scores revealed an interaction similar to that found for women's attitudes toward dieting. For women growing up in more stressful environments (+1 SD), harshness cues decreased desire to prevent weight gain relative to the control condition,  $\beta = .40$  ( $SE = .56$ ),  $t(4, 56) = 2.09$ ,  $p = .04$ . Conversely, for women growing up in less stressful environments (-1 SD), these cues promoted greater desire to prevent weight gain,  $\beta = -.35$  ( $SE = .52$ ),  $t(4, 56) = -1.95$ ,  $p = .056$  (see Fig. 4).



**Fig. 3.** Women's attitudes toward dieting as a function of condition (harshness vs. control) and childhood environmental stress (Study 3). Higher values correspond to more positive attitudes toward dieting.



**Fig. 4.** Women's desire to prevent weight gain as a function of condition (harshness vs. control) and childhood environmental stress (Study 3). Higher values correspond to greater desire to prevent weight gain.

We next probed the three-way interaction between condition, developmental stress, and BMI by testing the separate effects of developmental stress and BMI within each priming condition. Results for the control condition revealed neither a main effect of BMI nor an interaction between this factor and developmental stress on women's desire to prevent weight gain ( $p \geq .41$ ). For participants in the harsh ecology condition, however, results revealed a marginal interaction between BMI and developmental stress,  $\beta = .30$  ( $SE = .20$ ),  $t(3, 26) = 1.75$ ,  $p = .09$ . Although not conventionally significant, we probed this interaction by looking at the effect of BMI on women's desire to prevent weight gain at 1 SD above and below the mean on developmental stress. For women growing up in less stressful environments (1 SD below the mean), there was no effect of BMI on desire to prevent gain,  $p = .41$ . For women growing up in more stressful environments (1 SD above the mean), however, lower BMI was positively predictive of endorsement of beliefs that promote fat accumulation (i.e., diminished desire to prevent weight gain),  $\beta = .88$  ( $SE = .27$ ),  $t(3, 26) = 2.14$ ,  $p = .04$ .

## Discussion

Our third experiment examined whether ecological harshness cues have implications for women's attitudes toward dieting and preventing weight gain. The pattern of results found in Study 3 were consistent with the results of Studies 1 and 2, revealing that the effects of these cues on women's desire to restrict calories and prevent weight gain were critically dependent on their developmental history. For women growing up in more stressful childhood environments, cues indicating a harsh ecology both decreased positivity toward dieting and diminished their desire to prevent weight gain. Such changes were found to be most pronounced among women whose low BMI puts them at risk for suboptimal fertility. These results are consistent with contingent expression of a faster life history strategy and reflect changes that would facilitate meeting more immediate reproductive goals.

Harsh ecological cues had a markedly different effect on women reared in environments with less exposure to life history stressors, however. For women growing up in these less stressful, more predictable environments, harshness cues increased endorsement of attitudes promoting calorie restriction and prevention of weight gain. These results are consistent with contingent expression of a slower life history strategy and reflect changes that would facilitate delayed reproductive goals. This pattern of results is nearly identical to those found in Studies 1 and 2, suggesting that the effect of ecological harshness cues on women's food regulation psychology is both consistent and decisively dependent on theoretically meaningful differences in developmental history.

Importantly, although low BMI was found to be predictive of a stronger shift in favor of beliefs promoting weight gain among women from more stressful environments, high BMI did not produce a stronger desire

to restrict calories or prevent weight gain among women from less stressful environments. Although we did not anticipate this result in advance, it is likely that this occurred because the questions about dieting and weight prevention measured processes involved in preventing fat accumulation, rather than promoting weight loss. Therefore, endorsement of these beliefs is consistent both with weight loss for women with higher than average BMI and maintenance of low body weight among those with lower BMI.

## General discussion

Guided by insights from life history theory and the critical fat hypothesis, we tested whether cues that promote the contingent expression of life history strategies have implications for women's food regulation psychology. Because women can regulate their life history strategies by restricting or augmenting body fat, we predicted that women whose developmental histories favor slower life history strategies in harsh ecologies would respond to harshness by experiencing psychological changes promoting calorie restriction. Conversely, we predicted that women whose developmental histories favor faster life history strategies would respond to harshness cues by experiencing psychological changes promoting calorie consumption.

Across three experiments, a reliable pattern of findings emerged. First, consistent with research on the contingent expression of life history strategies (Griskevicius, Delton et al., 2011; Griskevicius, Tybur et al., 2011; Hill et al., under review), the effects of ecological harshness on women's food and weight regulation psychology differed depending on life history stressors present in childhood. For women growing up in more stressful childhood environments, harshness cues produced an increased desire for food and a diminished desire to restrict calories and prevent weight gain. Consistent with a faster life history strategy, such changes favor the accumulation of body fat necessary to maintain regular ovulation and successfully reproduce. In sharp contrast, for women growing up in less stressful environments, harshness cues produced a diminished desire for food and greater desire to restrict calories and prevent weight gain. Consistent with a slower life history strategy, such changes facilitate restriction of body fat and promote reproductive suppression. The moderating effect of these environmental stressors was nearly identical across studies, regardless of whether our measure assessed strictly economic deprivation (Studies 2 and 3) or also included questions assessing parental investment deprivation (Study 1).

Study 3 extended these results, demonstrating that the changes promoting food consumption and fat accumulation were strongest for women with lower BMIs. That is, women whose existing body fat was most at risk for falling below the reproductive threshold had the strongest response to cues promoting expression of faster life history strategies. Taken together, these results provide support for the hypothesis that ecological cues that promote the contingent expression of life history strategies may play a role in guiding women's calorie and weight regulation, yielding novel insights into some of the complex processes that influence women's attitudes toward food and dieting.

## Limitations and future directions

One important limitation of the current research is that our participants were college students. This population is more likely to come from middle- and upper-class backgrounds and to be following slower life history strategies. However, the variability among participants in our sample on critical variables (e.g., presence of childhood stressors) was comparable to that found in samples taken from more diverse populations (see e.g., Griskevicius et al., 2013). For example, each study contained a substantial number of participants who were both above and below the mid-point on our measures of childhood stress. Although future research is needed to examine these effects in more diverse populations, the current research found consistent evidence illustrating the

interactive effects of harshness cues and developmental stress among women who grew up in relatively advantaged socioeconomic backgrounds, speaking to the strength of these effects.

Because the current research primed ecological harshness by exposing participants to cues of heightened mortality risk, it is important to address whether we would expect any overlap between the results reported here and research conducted using a terror management theoretical (TMT; Greenberg, Pyszczynski, & Solomon, 1986) perspective. Although seemingly related, the methods and measures typically employed in TMT research diverge from those used in the current research in important ways. First, the cues to mortality risk employed in our studies were primed by having participants read fictitious news articles or slideshows describing recent increases in random acts of deadly violence. These explicit mortality threat primes are critically different from the more subtle mortality awareness primes used in TMT research. For example, TMT research is often conducted using subliminal primes that subconsciously activate death-related terms or employ a time lag that ensures that the death-related thoughts are removed from focal attention (see Greenberg et al., 2003; Pyszczynski, Greenberg, & Solomon, 1999). By contrast, perceived mortality risk was explicitly activated in the present research, and no delay was interposed prior to presenting the dependent measures. Indeed, prior work suggests that methods similar to those used in the current research produce an entirely different set of responses than the self-esteem striving and worldview defense predicted by TMT (see Greenberg, Arndt, Simon, Pyszczynski, & Solomon, 2000; Pyszczynski et al., 1999). It is therefore not surprising if the results of the current research are not altogether consistent with, or are potentially divergent from, similar issues addressed by TMT researchers. Importantly, the consistent pattern of results reported here is precisely the pattern that was predicted to emerge according to the life history perspective from which our predictions were derived.

That activating a faster life history strategy leads women to experience changes that facilitate fat accumulation, at first blush, may appear antithetical to women's mating goals given the very thin body ideal endorsed by women in the West (Swami et al., 2010). However, the results of Study 3 demonstrated that the changes in women's dieting attitudes that favor fat accumulation were driven primarily by women with a very low BMI. Accordingly, it is unlikely that the exhibited shifts would diminish the attractiveness of those women most likely to exhibit them. Furthermore, research indicates that men desire women's bodies to be significantly heavier than what women themselves most prefer (see e.g., Fallon & Rozin, 1985). Accordingly, psychological changes that promote fat accumulation may actually make women with very low BMIs more attractive to men, which would facilitate — rather than conflict with — their mate attraction goals. Future research is needed to explicitly examine perceived fertility-attractiveness trade-offs.

Despite these limitations, this research provides some of the first experimental evidence demonstrating a relationship between women's life history strategies and their calorie regulation psychology. By focusing on how harshness encountered in women's adult environments interacts with their developmental history, we demonstrated that the psychological processes related to women's food and weight regulation are guided, in part, by environmental contingencies that influence life history strategies. In so doing, this work makes a meaningful contribution to research on life history theory and evolutionary psychology, and our current understanding of the processes that guide women's body weight preferences and food regulation (e.g., Greeno & Wing, 1994; Griskevicius, Tybur et al., 2011; Kenrick, Griskevicius, Neuberg, & Schaller, 2010; Navarrete, Fessler, Fleischman, & Geyer, 2009; Salmon et al., 2008; Sobal & Stunkard, 1989; Tybur, Bryan, Magnan, & Hooper, 2011). It is our hope that the results of the current research will provide needed insight into existing environmental contingencies in women's food and weight regulation psychology, paving the way for new research into factors promoting eating disorders and body dissatisfaction, on one hand, and unhealthy weight gain, on the other.

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