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Published in:
Personality and Individual Differences

DOI:
10.1016/j.paid.2021.111261

Personality and Individual Differences 185 (2022) 111261

Contents lists available at ScienceDirect

Personality and Individual Differences

journal homepage: www.elsevier.com/locate/paid

Acute stress can boost and buffer hedonic consumption: The role of individual differences in consumer life history strategies☆

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ARTICLE INFO

Keywords:
Life history strategies
Stress
Hedonic consumption
Self-regulation

ABSTRACT

Mixed findings on the relationship between acute stress and the tendency to engage in hedonic food consumption suggest that stress may both boost and buffer hedonic eating. The present research aims to contribute to reconciling these mixed findings by focusing on the role of individual differences in consumer life history strategies (LHS) –short-term, impulsive, reward-sensitive (fast) vs. long-term, reflective, goal-oriented (slow) self-regulatory strategies– that might drive hedonic eating. We propose and show that stress may boost hedonic consumption among fast LHS consumers, while the relationship is buffered (non-significant) among their slow LHS counterparts. Moreover, we find that this stress-induced eating among fast LHS consumers is also cue-driven such that fast (but not slow) LHS consumers show a higher sensitivity to scarcity cues signaling the desirability of a palatable food under conditions of stress. Finally, we find that a cue indicating a high caloric content of the food may curb the tendency for fast LHS consumers to engage in (over) consumption of hedonic foods under stress.

1. Introduction

Does experiencing acute stress—the subjective experience of task demands exceeding one's coping resources (Starcke & Brand, 2016)—trigger hedonic consumption of sugary, or other energy dense foods and beverages? While it may seem evident to assume a straightforward causal link, the association between acute stress and hedonic food consumption is less unequivocal than it may appear (see Evers et al., 2018; Hill et al., 2018 for overviews). Indeed, findings on the stress-hedonic consumption relationship are mixed. A key objective of the present paper is to contribute to reconciling these divergent findings, by acknowledging that stress can simultaneously boost and buffer hedonic consumption, albeit for different types of consumers. More specifically, in the present series of studies we will focus on the role of individual differences in consumer life history strategies (Del Giudice, 2015; Kaplan & Gangestad, 2005; Mittal & Sundie, 2017).

1.1. *Stress and hedonic consumption*

The literature on whether acute stress boosts or buffers the tendency for hedonic consumption is fraught with conflicting findings. On the one hand, several studies point to a positive link between experiencing stress and the consumption of palatable, high caloric foods. For example, a recent meta-analysis (Ferrer et al., 2020) suggests that "incidental negative affect" (including acute -but not chronic- stress) may increase various appetitive risk behaviors, including (over)consumption of high caloric, sugary or salty palatable foods. This aligns with results of another meta-analysis that concluded that experimentally induced acute stress (typically induced via demanding tasks, frequently involving time pressure and/or (threat of) negative outcomes) may increase generalized reward sensitivity, rendering the individual more "attuned" to any stimulus that may predict a reward (Starcke & Brand, 2016). As various studies suggest, (cues to) palatable foods may well function in this role (see e.g., Pool et al., 2015). Indeed, previous research has demonstrated that experiencing acute stress increases hedonic consumption either via

☆ The authors wish to thank Susanu Baciu, Mathijs Dimmers, Remco Geerts, Sytze Hoekstra, Thom Neeleman, Simon Spoor, and Berthe Stummel for their input and assistance in data collection.

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https://doi.org/10.1016/j.paid.2021.111261
Received 29 December 2020; Received in revised form 6 September 2021; Accepted 7 September 2021
Available online 20 September 2021

the motivation to consume (wanting) and/or the hedonic experience (liking) of palatable foods (cf. Pool et al., 2015). For example, Michaud et al. (1990) compared patterns of food intake among high school students during stressful vs. less stressful events, and found that, compared to regular school days, students consumed 7% more calories (2225 kcal. on average) on exam days compared to regular days. Similarly, Oliver and Wardle (1999) showed that students report increased levels of snacking during stressful events. Finally, Zellner et al. (2007), using an experimental paradigm to induce acute stress (solving unsolvable anagrams under time pressure), showed that stress shifted food intake away from a healthy option (grapes), to a less healthy, more hedonic alternative (M&M's).

On the other hand, other research suggests that stress may *not* reliably affect hedonic food consumption. For example, a review by Torres and Nowson (2007) suggests that acute (in contrast to chronic) stress does not consistently increase food intake. This aligns with an earlier literature review (Greeno & Wing, 1994), which concluded that experimental studies have not found consistent effects of stress-induced food intake, except for restrained eaters. Indeed, focusing on experimentally-induced acute stress, Oliver et al. (2000) found no effects of stress on consumption motivation and intake of a wide range of available hedonic foods, including cookies, potato chips, sweets, ice cream, and chocolate. Similarly, Epel et al. (2001) either or not induced stress in the lab using a combination of a speech preparation, puzzle and math problem-solving task but did not observe a main effect on food intake. These findings converge with a more recent analysis (Evers et al., 2018) covering 56 experimental studies which failed to find consistent support for the notion that negative emotions (including -but not limited to- stress) increase an overall tendency for hedonic consumption (again, except for restrained eaters).

Such mixed findings in a given field may point either to a spurious or weak effect per se, or to the possibility that one or more (unobserved) moderator(s) may be at work, boosting the focal effect for some, while buffering it (rendering it non-significant) for others (Hayes, 2018). In the present paper we aim to contribute to reconciling these conflicting findings by highlighting the role of one specific moderator —individual differences in consumer life history strategies— that may shed light on when and why stress may boost and buffer hedonic consumption.

1.2. Stress, hedonic consumption and fast vs. slow life history strategies

Life History Theory (LHT; Del Giudice, 2015; Kaplan & Gangestad, 2005) provides a comprehensive and integrative framework that may aid in reconciling when acute stress promotes increased hedonic food intake and when it does not. More specifically, LHT originated from nonhuman research in the biological sciences (see e.g., MacArthur & Wilson, 1967; Pianka, 1970) stressing that across species traits pertaining to maturation, number of offspring and offspring investment tend to covary along a single fast-to-slow continuum as a function of environmental conditions of harshness and unpredictability. This notion was later adopted by the social and behavioral sciences (see e.g., Kaplan & Gangestad, 2005; Nettle & Frankenhuis, 2019) and translated to intraspecies, inter-individual postulates on human functioning informed by Darwinian principles of natural selection.

The basic tenets of LHT as applied to human, self-regulatory judgment and decision making, hold that –similar to nonhuman species– early life conditions shape and calibrate one's adaptive self-regulatory responses to maximize reproductive potential throughout the lifespan (Ellis & Del Giudice, 2019). More in particular, conditions of childhood harshness, unpredictability and resource scarcity signal that the future is uncertain and thus yield what is termed a *fast life history strategy* (fast LHS). Coping with such conditions during childhood affects judgment and decision making throughout the lifespan in predisposing fast LHS consumers to early reproduction and to adopt a short-term orientation, a tendency for risk-seeking and impulsive, reward-sensitive, appetitive judgment and decision making, aimed at immediate gratification of acute needs and wants. On the other end of the continuum are *slow LHS* consumers. Their childhood has typically been characterized by the opposite pattern: a relatively stable and predictable environment with abundant resources, signaling a certain and secure future. A slow LHS typically manifests itself in later reproduction, a focus on long-term goals, and a tendency for risk aversive, less appetitive, more reflective, controlled judgment and decision making (Del Giudice, 2015; Figueredo et al., 2006; Griskevicius et al., 2011; Hill et al., 2013; Hill et al., 2016; Kaplan & Gangestad, 2005; White et al., 2013).

Research using the LHS framework suggests that ceteris paribus, the tendency for hedonic consumption may be more pronounced for fast LHS individuals, compared to their slow LHS counterparts. Indeed, Maner et al. (2017) using both cross-sectional and longitudinal data showed that fast, compared to slow, LHS individuals tend to have a higher BMI, and show an increased propensity for dysregulated eating and obesity in adulthood. In line with these findings, Hill et al. (2016) observed that while slow LHS individuals tend to regulate their food intake as a function of their energy needs, fast LHS individuals do not and continue to consume higher amounts of food even when their energy need is low (i.e., when they are satiated).

However, to the best of the authors' knowledge, in contrast to these main effects, no research to date has yet addressed the *moderating* role of individual differences in LHS in accounting for the causal relationship between acute stress on the one hand and (over) consumption of hedonic foods on the other, a void that the present research aims to fill. Yet, in addition to the suggestive studies above, there is another compelling reason to consider the LHS construct as a key candidate to reconcile the mixed findings on this relationship. That is, research on sensitization and the adaptive role of stress suggests that the behavioral differences of fast vs. slow LHS consumers may particularly come to the fore under conditions in which these differences have been found to be particularly helpful for adapting to their respective environments—i.e., when facing stressful conditions (see Ellis & Del Giudice, 2019; Griskevicius et al., 2013). This perspective dovetails with recent research that suggests that high arousal states (such as stress) tend to inhibit the representation and impact of contextual cues on judgment and choice. Conversely, such states may facilitate the impact of less context dependent, more chronic individual dispositions, preferences, habits and traits (see Maran, Sachse, Martini, & Furtner, 2017; Maran, Sachse, Martini, Weber, et al., 2017; Schwabe & Wolf, 2009). To the extent that the fast-to-slow LHS continuum represents a stable and chronic individual difference, this implies that particularly under stressful conditions, we may see more pronounced differences in self-regulatory behavior between fast and slow LHS individuals, in line with their respective psychological "make up". Indeed, recent research by van der Linden et al. (2018) indicates that stress may induce a pro-active, reflective self-regulatory orientation among slow, but a reactive, impulsive self-regulatory orientation among fast LHS individuals.

Consequently, to the extent that fast LHS individuals are characterized by a short-term, impulsive, reward-sensitive, appetitive orientation (Del Giudice, 2014, 2015; Ellis & Del Giudice, 2019; Griskevicius et al., 2011), it stands to reason to expect that stressful conditions may trigger an increased appetite for and actual consumption of hedonic, sugary and/or energy dense foods, particularly among these consumers. In contrast, slow LHS individuals will be expected to be more controlled, less appetitive driven, and more reflective when confronted with a stressor (Ellis et al., 2009; Figueredo et al., 2006; Griskevicius et al., 2013). Thus, this orientation may well imply that experiencing stress will likely not translate into increased hedonic consumption among these consumers, thus rendering any impact of stress non-significant. In sum, our reasoning implies an ordinal interaction with individual differences in LHS modulating the effects of stress on hedonic consumption such that the impact of stress on hedonic consumption is boosted for fast, but buffered for slow LHS consumers. Experiments 1, 2, and 4 will test these notions.

1.3. Stress, LHS and cues to scarcity and calories

The present research will also, and more tentatively, explore a possible corollary of the present reasoning. Research on the relationship between stress, appetitive motivation and food intake both in human and nonhuman samples, has indicated that stress may increase the impact of any cue that is associated with palatable food and that may signal either the reward value or associated cost of the food (see Starcke & Brand, 2016). For example, Pool et al. (2015) examined the impact of a specific olfactory cue (a chocolate odor) signaling the reward value of a hedonic food (chocolate) under stressful and stress-free conditions, and found that particularly under stressful conditions, this cue increased participants' motivation to obtain it, as well as the hedonic pleasure during its consumption. Moreover, research on the *incentive salience* model (Berridge, 2007, see also Tindell et al., 2006) suggests that the neurotransmitter *dopamine* motivates reward pursuit by attributing incentive salience to reward-signaling ('wanting') cues. Interestingly, related work suggests that dopamine receptivity may be elevated by aversive states, such as stress (e.g., Tindell et al., 2006). This may imply that particularly under conditions of stress, such cues may either amplify (when highlighting the reward value of the palatable food) or stifle (when highlighting the associated cost or penalty of the palatable food) the appetitive drive toward and/or actual consumption of hedonic foods (cf. Starcke & Brand, 2016). Since we propose that stress may boost the (appetite for) hedonic consumption for fast, but not slow, LHS consumers, it may be plausible to assume that individual differences in consumer LHS will similarly moderate the effects of these cues under conditions of stress. Indeed, in keeping with the tenets of the incentive salience model, recent research suggests that fast LHS individuals may show an increased receptivity to dopamine (Minkov & Bond, 2015). The present reasoning thus implies that this stress-induced dopamine activation and its impact on the incentive salience of these cues may possibly be more pronounced for fast LHS consumers. Hence, we will explore whether fast LHS consumers show a higher sensitivity to these cues under conditions of stress than slow LHS consumers, for which the relationship between stress and hedonic consumption is posed to be non-significant. A typical cue that amplifies the reward value of (hedonic) foods is its scarcity –signaling uncertain availability (cf. Anselme & Güntürkün, 2019). Indeed, earlier research has shown that scarcity cues are particularly effective among fast, rather than slow LHS consumers (Fennis et al., 2020). Thus, we will explore whether for fast, but not slow LHS consumers, scarcity cues associated with the palatable food are particularly influential in promoting hedonic food consumption under conditions of acute stress. Experiment 3 will test this notion.

While scarcity cues may amplify fast LHS's consumers' tendency for hedonic consumption under conditions of stress, we will also explore whether cues warning consumers about the potentially unhealthy attributes of the palatable food may do the opposite and stifle this tendency. Indeed, previous research suggests that such warning labels can indeed sometimes be effective to reduce unhealthy food intake (see Ares et al., 2020; Clarke et al., 2020). The present research will examine the effectiveness of providing a cue, warning consumers of the high caloric content of the palatable food. Similar to the role of scarcity cues, we will explore whether fast, rather than slow LHS consumers show an increased sensitivity to these warning cues under stressful conditions. Three lines of research lend support for this contention. First, if fast LHS individuals indeed show an increased receptivity to dopamine (Minkov & Bond, 2015) and if the salience of reward-stifling cues (such as caloric warning cues) is indeed enhanced by dopamine activity, then increased sensitivity to these cues might decrease fast LHS consumers' motivation to pursue consumption of such cue-associated foods. Second, research on the LHS-obesity link has underscored that LHS and BMI tend to correlate, thus elevating the risk for obesity for fast LHS individuals (Maner et al., 2017). This may render fast LHS individuals possibly more sensitive to caloric warning cues then their slow LHS counterparts (see also Anderson et al., 2016). Third, in line with their elevated impulsiveness, fast LHS individuals' judgment and decision making may well be more impulsive and hence more heuristic-driven (Fennis et al., 2020; Strack & Deutsch, 2014). This is germane to the present research as warning cues have been found to indeed function as heuristics in contexts where people lack either the motivation and/or ability to engage in more extensive, reflective judgment and decision making (Fransen & Fennis, 2014; Janssen et al., 2010). If so, then when present, they may buffer the impact of stress on food intake for fast (but not slow) LHS consumers, and in so doing attenuate the differential effect of stress on hedonic consumption as a function of individual differences in LHS that is proposed when such cues are absent. Experiment 4 will examine this possibility.

2. The present research

Four experiments (total $N = 657$) tested our notions, conducted both in the field and online, including indices of appetitive motivation to acquire hedonic foods (i.e., willingness to pay), as well as actual or imagined food consumption (cf. Pool et al., 2015), and using multiple stressors and measures assessing individual differences in LHS. Experiment 1 and 2 were confirmatory in nature, while Experiment 3 and 4 build on these results but were of a more exploratory nature, probing possible 'downstream consequences' of the basic effect.

Experiment 1 set out to test the fundamental notion that acutely experienced stress may boost the tendency for hedonic consumption particularly among consumers with a fast, rather than slow LHS. Experiment 2 aimed to provide evidence for the robustness of the postulated moderated effect by (conceptually) replicating Experiment 1, using a different stressor on a larger sample, and relying on a different LHS measure to capture the main construct of interest. Experiment 3 and 4 explored possible corollaries of the main finding. Experiment 3 extended these results by assessing the impact on actual hedonic food intake and examined the notion that stress may increase the impact of scarcity cues on actual food intake, but only among fast, rather than slow LHS consumers. Finally, Experiment 4 examined the possibility that warning cues signaling the high caloric content of the palatable food may 'nudge' fast (rather than slow) LHS consumers to reduce their food intake under stressful conditions.

2.1. Sampling, sample sizes rationale and statistical power

For our studies we used convenience samples recruited by undergraduate students enrolled in a research project course at a Dutch university via a snowball approach using social media channels. We aimed to collect as many observations as possible given our time and budget resources. All participants included in the final samples participated voluntarily and provided informed consent.

To control Type 1 error, we followed recent recommendations (Perugini et al., 2018) and performed sensitivity power analyses on each of the four samples using *G*Power* (Faul et al., 2009). For this we used the meta analysis on stress-induced appetitive behavior as a starting point (see Ferrer et al., 2020), which reported an effect size of $f^2 = .06$ for the effect of stress on appetitive (risk) behavior (including snacking), placing the typical effect size in the small-to-medium range (Cohen, 1988). In line with this, sensitivity power analyses performed on the four samples also yielded effect sizes in the small-to-medium range. That is, the minimal effect sizes the present four studies were able to reliably observe, given the actual final sample sizes, 80% power and an α-error probability of .05 (using R^2 increase for a fixed multiple regression model, cf. Luttrell et al., 2017) ranged between $f^2 = -.02$ (Experiment 2) and $f^2 = -.08$ (Experiment 3, and 4; Experiment 1: $f^2 = -.04$). Thus, while the sensitivity power analyses of Experiment 3 and 4 suggest these to be viewed as exploratory and tentative rather than confirmatory and definitive, our studies appear adequately powered to be able to 'pick up' effects that are typically reported in the literature on stress-induced eating (cf. Ferrer et al., 2020).

For all studies, analyses were only conducted after data collection had ended. Moreover, it should be noted that chronologically, Experiment 2 followed the other three studies. This allowed us to also use the effect size of Experiment 1 as input for an a priori power analysis, which guided our sample size decisions for that study (see below for details).

2.2. Statistical analyses

For randomization checks to assess the distribution of gender, age and LHS across the experimental conditions, we used chi-square analyses (for gender) and one-way analysis of variance (for age and LHS). Across all studies, for the manipulation checks and the target analyses, we used multiple regression, employing the PROCESS macro (Hayes, 2018) due to the continuous nature of the LHS moderator. For all analyses, we considered results to be statistically significant if they fell below the $p = .05$ threshold.

3. Experiment 1

This first experiment tested the fundamental notion that acute stress may simultaneously boost and buffer the tendency for hedonic consumption, albeit for different groups of consumers. More specifically, we expected an ordinal interaction between acute stress and individual differences in consumer LHS, such that the effect of acute stress would be more pronounced for fast LHS consumers, while for their slow LHS counterparts, the effect would be non-significant.

3.1. Participants and design

Participants in this online study were told that they participated in two small, ostensibly unrelated studies on "human cognition and on consumer behavior" and were randomly assigned to conditions in a design with acute stress (high vs. low) as a between subjects factor and individual differences in LHS as a measured continuous independent variable.[1] Three participants were discarded due to missing values on the key constructs. Retaining all valid (i.e., non-missing) observations yielded a sample of 182 participants of various ages ($M = 28.73$ $SD = 13.39$, 52.2% female) and professions (55% students, 41% having a professional job, 2% unemployed, 2% missing/N/A).

3.2. Procedure and measures

In this study, as well as in Experiment 3 and 4, we varied the levels of acutely experienced stress, by asking all participants to complete a mathematical reasoning task adapted from the Montreal Imaging Stress Task (Acar-Burkay & Cristian, 2019; Dedovic et al., 2005), comprised of 13 mathematical problems, without the use of paper, pencil or electronic devices. In the high stress condition, these math problems had to be solved under time pressure (10 s. per problem), and participants received feedback that their performance was 10% worse than average. In the low stress condition, there was no time pressure and feedback indicated that the participant's performance was similar to that of the other participants (cf. Dedovic et al., 2005; see also Starcke & Brand, 2016).

After the task, and presented as a second, ostensibly unrelated study, participants were asked to imagine visiting their regular supermarket for groceries. We compiled a list of 27 typical daily/weekly groceries, based on previous research (e.g., Gineikiene & Diamantopoulos, 2017; Vohs & Faber, 2007), and allowed participants to spend as much or as little as they wished on each of the products. The list contained both food (e.g., bread, apples) and non-food products (e.g., detergent, toilet paper). Moreover, in addition to more 'utilitarian' foods (e.g., milk, broccoli, radish), we included a number of hedonic snack and dessert foods in line with previous research (Oliver et al., 2000), such as chocolate, potato chips, and ice cream (see Appendix 8.1 for a full list of the 27 products). Following Oliver et al. (2000), we calculated the willingness to pay as the proportion spent on five hedonic food products (cookies, potato chips, sweets, ice cream, and chocolate). We used this proportion as our main dependent variable—appetitive motivation to acquire hedonic foods ($M = .25$, $SD = .07$).

In all studies, we gauged the level of acutely experienced stress as a function of the task using a 7-point Likert scale asking participants how stressful the task made them feel, with higher scores indicating stronger feelings of stress ($M = 3.58$, $SD = 2.00$). Moreover, in this study, as well as in Experiment 3 and 4 we measured individual differences in consumer LHS using the validated and frequently used Mini-K scale (Figueredo et al., 2006; Maner et al., 2017; Olderbak et al., 2014; van der Linden et al., 2018). This scale includes items such as: "I often make plans in advance", "I avoid taking risks", and "While growing up, I had a close and warm relationship with my biological mother" (see Figueredo et al., 2006 for a full listing of the items) and uses a 7-point Likert format (1 = strongly disagree, 7 = strongly agree). Scores on the items were averaged to create an overall LHS index with lower scores indicating a faster LHS (and higher scores indicating a slower LHS; $M = 5.22$, $SD = .52$; Cronbach's $\alpha = .66$).[2]

Finally, to assess the robustness of our findings, we measured participants' subjective current socio-economic status (SES) using three, 9-point Likert statements (Griskevicius et al., 2011): "I have enough money to buy things I want", "I don't need to worry too much about paying my bills", and "I don't think I'll have to worry about money too much in the future" ($M = 6.98$, $SD = 1.31$, Cronbach's $\alpha = .75$).

3.3. Results and discussion

3.3.1. Preliminary analyses

Randomization checks confirmed that gender (χ^2 (df = 1) = .17, $p = .68$), as well as age and LHS were indeed randomly and evenly distributed across the two experimental conditions (F (1, 180) = .58, $p = .45$, and F (1, 180) = .94, $p = .33$, respectively). Given the continuous nature of our moderator, LHS, we used multiple regression analyses using PROCESS (model 1, see Hayes, 2018) in all subsequent analyses.

First, the manipulation of acute stress was successful as the mathematical reasoning task including time pressure and negative feedback indeed elicited significantly more stress ($M_{\text{high stress}} = 4.48$, $SD_{\text{high stress}} = 1.64$) than the task without time pressure and with neutral feedback (vs. $M_{\text{low stress}} = 3.05$, $SD_{\text{low stress}} = 1.74$). Indeed a regression analysis using the stress manipulation check as criterion, and the stress task (effects coded), LHS and its interaction and predictors, yielded a significant impact of the stress task ($\beta = 1.21$, $SE = .12$, $t(178) = 10.20$, $p < .0001$ all coefficients standardized), while the impact of LHS was non-significant ($\beta = -.07$, $SE = .07$ $t(178) = -1.11$, $p = .27$) as was the interaction effect ($\beta = -.09$, $SE = .12$, t (178) = $-.72$, $p = .47$). Thus, the manipulation of stress was successful while ruling out alternate effects such as an overall effect of LHS on feelings of task-induced stress or differential stress-elicitation of the task as a function of LHS.

[1] Note: All studies included additional items at the end of the questionnaires that were included for exploratory purposes (e.g., measures of dispositional attitudes, trait self-control and impulsivity, uncertainty tolerance and leisure time exercise). Since these were not focal to the present investigation we did not analyze these data.

[2] Note: in all studies we also included a measure of childhood SES, a variable that is sometimes considered a 'rival' proxy of LHS (although probably better conceived of as its distal predictor, see Maner et al., 2017). Throughout our studies, while the LHS and childhood SES measure proved to be significantly correlated (all $rs > .17$, $ps < .05$), the predictive validity of the LHS measures consistently outperformed that of the child SES measure, and so we focus our analyses on the former.

3.3.2. Target analysis

We tested the key hypothesis that acute, task-induced stress boosts the tendency to engage in hedonic consumption among fast but not slow LHS consumers using a multiple regression analysis with the proportion willing to spend on hedonic foods as criterion and stress (low vs. high, effects coded), LHS and their interaction as predictors. The results of this analysis yielded only a significant interaction effect between stress and LHS on the tendency to engage in hedonic consumption ($\beta = -.34$, $SE = .15$, $t(178) = -2.23$, $p = .03$). Additional spotlight analyses to probe the interaction (cf. Spiller et al., 2013) indeed confirmed that stress increased the tendency for hedonic consumption among fast LHS consumers ($\beta = .46$, $SE = .21$, $t(178) = 2.21$, $p = .03$) while the effect was non-significant for slow LHS consumers ($\beta = -.21$, $SE = .21$, $t(178) = -.99$, $p = .32$, evaluated at - / + 1 SD from the mean, respectively). A follow-up floodlight analysis (see Spiller et al., 2013) exploring the effect of stress across the full range of observed values of the moderator (LHS), confirmed that the interaction was indeed ordinal (rather than crossover), since it indicated only one transition point where the effect changed from non-significant to significant (JN value = 4.67), indicating (in terms of units *SD*) a region of significance including values at or below LHS = $M - (0.67 * SD)$, covering 24% of the sample. Finally, reanalyzing the data including participants' current SES as a covariate yielded similar results ($\beta = -.34$, $SE = .15$, $t(177) = -2.30$, $p = .02$, for the critical interaction) indicating that the effect is robust when controlling for current SES.

In sum, this study yields first evidence showing that individual differences in the fast-to-slow continuum of consumer life history strategies may be meaningful in reconciling conflicting findings in the literature on the relationship between acute stress and hedonic consumption. That is, acute stress indeed boosts the tendency for hedonic consumption (appetitive motivation to acquire hedonic foods) among fast LHS consumers, while the effect is non-significant for consumers with slow life history strategies.

4. Experiment 2

This study served to provide converging evidence for the results of Experiment 1. To that end the Experiment 2 was set up to provide a conceptual replication of the previous study, maintaining the same hedonic consumption measure as the target dependent variable, but using a different stress manipulation to assess whether the previous effects were constrained to the type of stressor. Moreover, to account for the typical and reported modest reliability of the Mini-K (see Figueredo et al., 2017), the present experiment used the more elaborate recently developed and validated K-SF-42 measure (Figueredo et al., 2017).

4.1. Participants and design

To warrant adequate statistical power to detect the critical interaction observed in Experiment 1, we performed an a priori power analysis using R^2 increase for a fixed multiple regression model (cf. Luttrell et al., 2017) given that our data require the use of multiple regression or analysis. Using the effect size observed in the previous study as input ($f^2 = .03$), this analysis yielded a requested sample size of $N = 264$ to attain 80% power (at α = 05) to replicate the LHS* stress interaction. We decided to use this sample size as a minimum and to continue data collection as long as time and budget resources would allow. Using the same design as in the previous study, this yielded a sample of $N = 278$ participants of various ages ($M = 34.46$ $SD = 14.55$, 50% female) and professions (13% students, 26% having a professional job, 48% unemployed, 13% missing/other) who were randomly assigned to the high and low stress conditions.

4.2. Procedure and measures

This study was introduced as two separate studies on human cognition and spending behavior and used a stress manipulation adapted from Griskevicius et al. (2013). More specifically, in the high-stress condition, participants were asked to read a newspaper article ostensibly from the Sunday section of *the Guardian* about an upcoming economic recession. The article was titled "Tough Times Ahead: The New Economics of the 21st Century" and described an upcoming economic recession fueled "by the crippling COVID-19 pandemic, the raging global trade war between the US, China and Europe, the Brexit, the immigration crisis in Europe and the continuing instability in the Middle East". In the low-stress condition, participants read a newspaper article titled "Peaceful Meadow Relaxation" describing how regular relaxation training can foster balance and peace of mind (see Appendix 8.2 for the full text of both articles). Following reading the article, participants were asked to write about their thoughts and feelings when reading the article.

After the reading and writing task we administered the same willingness to pay-task used in Experiment 1 to gauge hedonic consumption. Similar to the previous study, and based on previous research (Oliver et al., 2000), we calculated the willingness to pay as the proportion spent on five hedonic food products (cookies, potato chips, sweets, ice cream, and chocolate). We used this proportion as our main dependent variable—appetitive motivation to acquire hedonic foods ($M = .18$, $SD = .06$).

Similar to the previous study, participants also indicated how stressful the reading and writing task made them feel ($M = 3.13$, $SD = 1.19$). In the present study, to assess individual differences in LHS, we used a more elaborate measure than the 20-item Mini-K to account for its typical low reliability —the K-SF-42 (Figueredo et al., 2017). This scale consists of 42 items adopted from the 199 item Arizona Life History Battery (see Figueredo et al., 2014) using both 7-point Likert statements and 4-point frequency ratings. This scale includes items such as "When faced with a bad situation, I do what I can to change it for the better", "Even when everything seems to be going wrong, I can usually find a bright side to the situation", and "How much have your friends helped you get worries off your mind?". We averaged scores to create an overall LHS index with lower scores indicating a faster LHS (and higher scores indicating a lower LHS; $M = 3.96$, $SD = .62$; Cronbach's α = .89).

Finally, to assess the robustness of our findings, we again measured participants' subjective current SES using the same measure used in Experiment 1 ($M = 6.29$, $SD = 1.69$, Cronbach's α = .83).

4.3. Results and discussion

4.3.1. Preliminary analyses

Randomization checks confirmed that gender (χ^2 (df = 2) = .97, $p = .62$), as well as age and LHS were indeed randomly and evenly distributed across the two stress conditions ($F(1, 276) = .91$, $p = .34$, and $F(1, 276) = 1.25$, $p = .27$, respectively). Similar to the previous study, given the continuous nature of our moderator, LHS, we used multiple regression analyses using PROCESS (model 1, see Hayes, 2018) in all subsequent analyses.

First, the manipulation of acute stress was successful as the high-stress newspaper article evoked significantly more stress ($M_{\text{high stress}} = 4.30$, $SD_{\text{high stress}} = 1.68$) than the low-stress newspaper article (vs. $M_{\text{low stress}} = 1.88$, $SD_{\text{low stress}} = 1.26$). Indeed, in line with Experiment 1, a regression analysis using the stress manipulation check as criterion, and the stress task (effects coded), LHS and its interaction and predictors, yielded a significant impact of the stress task, similar in size as the one observed in Experiment 1 ($\beta = 1.24$, $SE = .09$, t(274) = 13.42, $p < .0001$, all coefficients standardized), as well as an impact of LHS ($\beta = -.11$, $SE = .05$, $t(274) = -2.15$, $p = .03$). The interaction between stress and LHS was non-significant ($\beta = -.03$, $SE = .05$ $t(274) = -.53$, $p = .59$).

4.3.2. Target analysis

We replicated the target regression analysis on the same measure of hedonic consumption as used in Experiment 1. This analysis again only yielded a significant interaction effect between stress and LHS on the tendency to engage in hedonic consumption ($\beta = -.29$, $SE = .12$, $t(274) = -2.41$, $p = .02$). Similar to the previous study, additional spotlight analyses to probe the interaction (cf. Spiller et al., 2013) showed that stress increased the tendency for hedonic consumption among fast LHS consumers ($\beta = .35$, $SE = .17$, $t(274) = 2.06$, $p = .04$), but not among slow LHS consumers for which the simple effect was non-significant ($\beta = -.23$, $SE = .17$, $t(274) = -1.38$, $p = .17$, evaluated at - / + 1 SD from the mean, respectively). The results again proved robust when controlling for current SES, since adding this variable as a covariate did not change the results ($\beta = -.29$, $SE = .12$, t(273) $= -2.36$, $p = .02$ for the critical interaction).

Hence, using a larger sample size informed by the effect size of Experiment 1, as well as a different stress manipulation and a different measure of LHS, the present study was able to replicate the basic pattern found in Experiment 1—acute stress can boost and buffer (appetitive motivation for) hedonic consumption, albeit for different types of consumers.

5. Experiment 3

Experiment 3 extends the previous results by exploring a direct corollary of the reasoning outlined above. As highlighted, research on appetitive motivation and food intake has shown that stress may increase the impact of any cue that is associated with palatable food and that may signal the reward value or associated cost of the food. Since the previous studies showed that stress boosts the tendency for hedonic consumption for fast, but not slow, LHS consumers, we focus on scarcity cues which previous research has indicated to particularly 'fit' these consumers' self-regulatory focus (Fennis et al., 2020). We explore the possibility that for these consumers, scarcity cues associated with the palatable food are particularly influential in shaping hedonic food consumption under conditions of stress. We examined our notions in the field focusing on actual food intake as our main dependent variable.

Please note that, for this and the next study, while sensitivity power analyses using *G*Power* (Faul et al., 2009) indicated adequate sample sizes to 'pick up' a small to medium effect size ($f^2 = .08$ for both studies), the power and sensitivity of these studies is lower than the previous ones and what would be desirable given the effect size reported by Ferrer et al. (2020) in their meta-analysis on the link between stress and appetitive (risk) behavior ($f^2 = .06$, which would require a sample size of $N = 133$, given 80% power and $\alpha = .05$; cf. Faul et al., 2009). Hence, the results should be treated more as exploratory and tentative rather than confirmatory.

5.1. Participants and design

The present field experiment used a design with acute stress (high vs. low) and scarcity cue (present vs. absent) as between subjects' factors and individual differences in consumer LHS as a measured independent variable. A total of 101 consumers with a mean age of 27.18 ($SD = 8.13$, 51% male) and various educational backgrounds (13% MSc, 22% BSc, 52% Polytechnic degree; 12% Professional degree, 1% other) were randomly assigned to the stress and scarcity cue conditions, and participated voluntarily.

5.2. Procedure and measures

A research assistant approached participants at various locations of a mid-sized Dutch town and asked them to participate voluntarily in two small studies (presented as unrelated) with the aim to examine how people process information and how this influences performance. We used the same stress task as in Experiment 1. Similar to the previous studies, participants indicated how stressful the task made them feel ($M = 4.56$, $SD = 1.79$). Following the stress task, participants were led to believe they moved on to the next study, which involved a taste test. In line with Zellner et al. (2007), all participants were asked to taste M&M chocolates that were presented to them in a bowl. They were told to take as many or as few as they wished. Importantly, in the scarcity cue-present condition, participants were informed that the M&Ms. were a 'limited edition' item, while no such reference was made in the control condition. The number of M&Ms. consumed (calculated as the difference in the number per bowl at the start vs. finish of each trial) constituted the key DV in this study ($M = 18.71$, $SD = 10.18$).

Following the consumption task, we again assessed individual differences in LHS using the Mini-K (Figueredo et al., 2006). Possibly due to the intrinsically "noisy" nature of research in the field, adding to the already modest reliability Mini-K, as acknowledged in the literature (see Figueredo et al., 2017), Cronbach's only reached $\alpha = .57$, thus failing to reach the conventional threshold of .60 signaling at least moderate reliability (cf. Taber, 2018; van Griethuijsen et al., 2015). Hence, we followed the procedure outlined by van der Linden et al. (2017, see also van der Linden et al., 2015, 2018) and used the general factor approach for creating an overall LHS measure. Specifically, we used principal axis factoring and extracted the first (unrotated) factor using the regression method. This factor explained 16% of the observed shared variance in the Mini-K measure. Hence, in line with van der Linden et al. (2015, 2017, 2018) we used these factor scores as a measure of LHS with higher scores indicating a slower LHS.[3].

5.3. Results and discussion

5.3.1. Preliminary analyses

Similar to the previous study, a randomization check showed that gender (χ^2 (df = 3) = 1.15, $p = .77$), age (F (3, 97) = .20, $p = .90$) and LHS (F (3, 97) = .51, $p = .67$) were all randomly distributed across the two experimental conditions of both manipulated variables. Similar to the previous study, given the continuous nature of our moderator, LHS, we used multiple regression analyses using PROCESS (model 3, see Hayes, 2018) in all subsequent analyses.

The manipulation of acute stress was again successful as the mathematical reasoning task including time pressure and negative feedback elicited significantly more stress ($M_{\text{high stress}} = 5.65$, $SD_{\text{high stress}} = 1.38$) than the task without time pressure and with neutral feedback ($M_{\text{low stress}} = 3.64$, $SD_{\text{low stress}} = 1.59$). Indeed a regression analysis using the stress manipulation check as criterion, and the stress task, scarcity (both effects coded), LHS and all two and 3 way interactions as predictors, only yielded a significant impact of the stress task, which matched the strength of the effect of Experiment 1and 2 ($\beta = 1.15$, $SE = .17$, $t(93) = 6.85$, $p < .001$), while all other main and interaction effects were non-significant (all $ps > .07$). Thus, the manipulation of stress was successful and unconfounded by any of the other variables included in the present design.

5.3.2. Target analysis

We examined the possibility that for fast, but not slow LHS consumers, a scarcity cue associated with the M&M's might show a more pronounced impact on actual hedonic food intake under conditions of stress. To this end we regressed amount of M&M's consumed on stress (low vs. high, effects coded), scarcity cue (absent vs. present, effects coded), LHS and all two-way and three-way interactions as predictors. The results of this analysis showed a main effect of stress, indicating that high stress induced increased M&M consumption, compared to low stress ($\beta = .76$, $SE = .18$, $t(93) = 4.24$, $p < .0001$). Moreover, a second

[3] Note: To be fully consistent, we also reanalyzed the data of Experiment 1, 2, and 4 using the same general factor approach. These analyses yielded results similar to using means, i.e., for Experiment 1: $\beta = -.29$, $SE = .15$, $t(178) = -1.96$, $p = .05$, for Experiment 2: $\beta = -.31$, $SE = .12$, $t(274) = -2.67$, $p = .008$; and for Experiment 4, $\beta = -1.14$, $SE = .44$, $t(88) = -2.59$, $p = .01$ for the critical two and three-way interaction effects, respectively.

main effect indicated that the presence of a scarcity cue promoted increased M&M intake compared to its absence ($\beta = .47$, $SE = .18$, $t(93) = 2.63$, $p = .01$). Of more interest was the observation that three-way interaction between LHS, stress, and scarcity also emerged ($\beta = -.83$, $SE = .41$, $t(93) = -2.04$, $p = .04$).[4] Additional (spotlight) analyses to probe the interaction (cf. Spiller et al., 2013) indeed showed that the impact of the scarcity cue (present vs. absent) under conditions of stress (high vs. low) was only significant for consumers with a fast LHS ($\beta = 1.21$, $F(1, 93) = 4.72$, $p = .03$, evaluated at $M - 1$ SD), but not for their slow LHS counterparts ($\beta = -.45$, $F(1, 93) = .73$, $p = .40$, evaluated at $M + 1$ SD). More in particular, corroborating the notion that stress may increase sensitivity to cues that signal the reward properties of palatable foods (cf. Pool et al., 2015), we observed that for fast LHS consumers, the scarcity cue was particular influential in promoting increased M&M's consumption under conditions of high stress ($\beta = 1.13$, $SE = .42$, $t(93) = 2.70$, $p = .008$), rather than low stress ($\beta = -.08$, $SE = .37$, $t(93) = -.21$, $p = .83$).

In sum, the present findings build on the results of the previous studies by suggesting a direct corollary of the differential impact of stress on hedonic consumption as a function of individual differences in consumer LHS. Since fast LHS consumers are more prone to engage in hedonic consumption than their slow LHS counterparts under conditions of stress, it was plausible to assess whether stress-induced cue effects on hedonic consumption would similarly be more pronounced for the former than the latter. The results of the present study provided tentative support for this notion and showed that for fast LHS consumers, a scarcity cue increased M&M consumption more under conditions of high stress, than low stress.

While Experiments 1, 2, and 3 suggest that fast LHS consumers may be more at risk to engage in increased consumption of high caloric, sugary and/or salty foods, the third and final experiment explores the effectiveness of a warning cue of high caloric content of the food, which might function as a simple 'nudge' to curb this potentially harmful impact of stress on fast LHS individuals' tendency for hedonic consumption.

6. Experiment 4

If stress prompts fast, but not slow, LHS consumers to engage in hedonic consumption, and if cues that highlight the reward value of the food are particularly impactful for these consumers, then cues that signal the associated cost or 'penalty' of the palatable food may do the opposite and may stifle food intake under these conditions This possibility was explored in the last study where we examined whether 'nudging' fast LHS consumers to moderate their consumption by signaling the high caloric content of the food might help to curb the effect of stress on hedonic food intake. Hence, in line with the previous studies, we explored whether the impact of the cue to the high caloric content of the food would be particularly pronounced for fast LHS consumers. More specifically, under default (no caloric cue) conditions, we assessed whether the results observed in Experiment 1 and 2 could be replicated, i.e., whether individual differences in LHS modulate the impact of stress on hedonic food consumption. However, when a cue signaling high caloric content is present, the effect of stress on hedonic food consumption for fast LHS consumers might be non-significant, similar to what is observed for slow LHS consumers.

6.1. Participants and design

In this (online) study, we used a design with acute stress (high vs. low) and cue to high caloric content (present vs. absent) as between subjects' factors and individual differences in consumer LHS as a measured independent variable. The sample consisted of 96 consumers with a mean age of 24.60 ($SD = 6.25$, 65% female) that were randomly assigned to the stress and caloric cue conditions, and participated voluntarily (77% students, 14% having a professional job, 4% unemployed and 5% other).

6.2. Procedure and measures

The set up and procedure converged with that of the previous study, except for the online data collection and cue manipulation. Thus, participants were asked to participate in two small, ostensibly unrelated studies on "human cognition and consumer behavior". We again used the same stress task as in the previous studies. Next, framed as the second study, the (virtual) M&M's tasting task and caloric cue manipulation were introduced. All participants were asked to "imagine that you are hungry and looking for a snack. You decide to go to the supermarket and you end up in front of the shelf filled with chocolates. You see this M&M package". All participants were shown a "Large, 255 grams" package of M&M's. We manipulated the presence/absence of a cue warning of high caloric content by either or not displaying a label "high in calories" on the package (covering 10.7% of the surface area of the package). All participants were asked to indicate how many individual M&M's chocolates (and not how many bags of M&M's) they would like to consume and were informed they could take as many or as few as they wished. In line with the previous study and Zellner et al. (2007), the number of M&M's. they wanted to consume constituted the key dependent variable in this study ($M = 19.6$, $SD = 25.13$).

Next, and similar to the previous studies, we gauged the effectiveness of the stress manipulation by asking participants to indicate on a 7-point scale how stressful the task made them feel ($M = 4.19$, $SD = 2.14$). Moreover, we again assessed individual differences in LHS using the Mini-K (Figueredo et al., 2006; $M = 4.98$, $SD = .70$, Cronbach's $\alpha = .74$).

6.3. Results and discussion

6.3.1. Preliminary analyses

Similar to the previous studies, we conducted a check to ascertain the successful randomization of participants in terms of gender, age and the LHS measure across conditions. This analysis showed that gender (χ^2 (df $= 3) = 2.42$, $p = .49$), age ($F(3, 92) = .57$, $p = .64$), and LHS ($F(3, 92) = 1.61$, $p = .19$) were all randomly distributed across the two conditions of the manipulated variables. Hence, randomization was successful

Similar to the previous studies, given the continuous nature of our moderator, LHS, we used multiple regression analyses using PROCESS (model 3, see Hayes, 2018) in all subsequent analyses. The manipulation of acute stress was again successful as the mathematical reasoning task including time pressure and negative feedback indeed elicited significantly more stress ($M_{\text{high stress}} = 5.16$, $SD_{\text{stress}} = 1.97$) than the task without time pressure and with neutral feedback (vs. $M_{\text{low stress}} = 3.17$, $SD_{\text{low stress}} = 1.82$). A regression analysis using the stress manipulation check as criterion, and the stress task (effects coded), LHS, caloric cue manipulation (effects coded) and all two and 3 way interactions as predictors, again yielded a significant impact of the stress task in line with the previous studies ($\beta = .98$, $SE = .18$, $t(88) = 5.37$, $p < .0001$). All other main and interaction effects were non-significant (all ps $> .12$), except the three way interaction between stress, LHS and the caloric cue manipulation ($\beta = .88$, $SE = .38$, $t(88) = 2.35$, $p = .02$). Although this three-way interaction signaled a difference in strength of the two 2-way interactions (between stress and LHS) for the cue absent vs. cue present conditions, both these 2-way interactions failed to reach significance themselves ($p = .11$, for the cue absent condition and $p = .09$, for the cue

[4] Re-analyzing the data using the average Mini-K scores as a measure of LHS also yielded a significant main effect of stress ($\beta = .72$, $SE = .18$, $t(93) = 4.04$, $p = .0001$), and scarcity cue ($\beta = .42$, $SE = .18$, $t(93) = 2.33$, $p = .02$). In addition, the interaction between LHS and stress approached significance ($\beta = .37$, $SE = .19$, $t(93) = 1.94$, $p = .055$).

present condition). This suggests that both for the caloric cue absent, and the caloric cue present conditions, there is no significant difference in the effectiveness of the stress task as a function of LHS. Thus, we conclude that the manipulation of stress was successful and is unconfounded by any of the other variables included in the present design.

6.3.2. Target analysis

We examined the possibility that the presence of a warning cue signaling the high caloric content of the food may attenuate the impact of stress on hedonic food intake for fast (rather than slow) LHS consumers using PROCESS (model 3, Hayes, 2018). Hence we regressed the (desired) amount of M&M's consumed on stress (low vs. high, effects coded), LHS, caloric cue (absent vs. present, effects coded) and all two-way and three-way interactions. The results of this analysis showed a main effect of cue, indicating that the presence of a cue indicating high caloric content reduced desired M&M consumption, compared to its absence ($\beta = -.49$, $SE = .20$, $t(88) = -2.51$, $p = .01$). Moreover, a significant two-way interaction between stress and LHS emerged that paralleled the results found in Experiment 1 ($\beta = -.58$, $SE = .20$, $t(88) = -2.88$, $p = .005$). Importantly, this interaction was qualified by the three-way interaction between stress, LHS and caloric cue ($\beta = .83$, $SE = .41$, $t(88) = 2.05$, $p = .04$).[5] Additional simple slopes analyses to probe the full, three-way interaction, indicated that the two-way interaction between stress and LHS was only significant when the cue was absent ($\beta = -1.00$, $F(1, 88) = 11.18$, $p = .001$), but not when it was present ($\beta = -.17$, $F(1, 88) = .38$, $p = .54$).[6] When the cue was absent, the results replicated the main findings observed in Experiment 1. That is, stress increased (desired) consumption of M&M's for fast LHS consumers ($\beta = 1.36$, $SE = .44$, $t(88) = 3.09$, $p = .003$, evaluated at $M - 1\ SD$), but not their slow LHS counterparts ($\beta = -.64$, $SE = .36$, $t(88) = -1.76$, $p = .08$, evaluated at $M + 1\ SD$).

However, when the cue signaled the high caloric content of the M&M's, this differential effect of stress on hedonic consumption for fast vs. slow LHS consumers vanished, and hence, across the entire fast-to-slow LHS continuum, no effects of stress on hedonic consumption were observed anymore (all $ps > .31$). Thus, the cue proved effective in attenuating fast consumers' tendency to engage in hedonic food consumption when under stress, similar to what is observed for slow LHS consumers.

7. General discussion

The present research aimed to reconcile mixed findings on the relationship between stress and hedonic food consumption by focusing on the role of individual differences in consumer life history strategies. More specifically, in keeping with the gist of the literature, we proposed that stress may both boost and buffer hedonic motivation and eating, albeit for different groups of consumers (cf. Evers et al., 2018; Ferrer et al., 2020; Starcke & Brand, 2016; Torres & Nowson, 2007). We demonstrated that fast LHS consumers tend to respond to stress with an increased motivation to acquire hedonic foods and an increased tendency to actually consume these. Thus, stress boosts hedonic consumption for these consumers. For slow LHS consumers, in contrast, the relationship between stress and hedonic consumption is non-significant, in line with the body of work that failed to find a consistent effect of stress on eating (cf. Evers et al., 2018; Torres & Nowson, 2007). As such, the present findings may shed additional light on when and why the stress-eating link is observed and when it is not, thus contributing to the resolution of the mixed and sometimes contradictory findings that have been observed on the relationship. Indeed, while the overall zero-order bivariate correlations between stress and hedonic consumption are small across the present studies, possibly reflecting these mixed results (see Appendix 8.3 for the zero-order correlations between the target constructs per study), accounting for the moderating role of LHS appears to bring more clarity to the picture.

Of course, it should be noted that we do not claim that the observed modulation of the stress-eating relationship by LHS constitutes the final or even only answer reconciling the equivocal 'state of the science' on the issue. It may well be that additional moderators such as the type of stressor, the duration and/or intensity of the stress, the time lag between the experienced stress and the opportunity for hedonic consumption, or additional environmental factors (e.g., social support) may also be able to contribute to our understanding of the issue, either in isolation, or in conjunction with LHS. Yet, the findings do show the promise of using a perspective informed by evolutionary theorizing (Life History Theory) for that purpose (see also Otterbring et al., 2020). Indeed, given the broad range of traits, self-regulatory behaviors and the broad repertoire of coping responses that is captured by the fast-to-slow continuum (see Figueredo et al., 2006), one may argue that the explanatory power of the LHS construct is at least on par, and possibly larger than what is typically observed for a given individual difference characteristic or personality trait (see Gignac & Szodorai, 2016).

We also explored a direct corollary of the present reasoning, examining the role of cues, associated with palatable foods that may either amplify (i.e., cues to scarcity) or stifle (i.e., cues to high caloric content) the tendency to engage in hedonic food intake, particularly when stress is high (vs. low, cf. Pool et al., 2015). We found that under high stress (but not low stress) these cues indeed increase (scarcity cues) or decrease (caloric cues) the actual and desired consumption of hedonic foods (M&M's). However, in keeping with the reasoning of the present research, these effects were not observed for all participants, but were limited to those consumers for whom the stress-eating link was established in the first place –consumers with a fast LHS.

Overall, we found support for our notions across a total of $N = 657$ consumers, including "real" consumers (in addition to undergraduate students), both online and in the field, using validated tasks and measures, and including both indices of the motivation to acquire hedonic foods (willingness to pay for such foods, cf. Oliver et al., 2000) and actual (and desired) food intake (cf. Zellner et al., 2007). Interestingly, these latter aspects suggest that the effects of acute stress on hedonic consumption for fast LHS consumers may well extend beyond the actual stress-inducing context. Indeed, while a fast LHS is associated with more impulsive judgment and choice (see Fennis et al., 2020; van der Linden et al., 2018), and so renders the ad-hoc impact of stress on food intake in that context likely and plausible, the effects on purchase intentions (willingness to pay) suggest that stress induced food consumption may well stretch over a longer time interval, when the acquired foods are actually consumed. This may potentially contribute to the pattern observed by Maner et al. (2017) that indicate that a fast LHS associates with (chronic) dysregulated eating and resulting obesity in adult life.

While part of the present results paints a fairly dark picture about the possibly risky and health-impairing effects of stress, at least for fast LHS consumers, the results of the fourth study also present a small, and only tentative, 'ray of light', showing that those most at risk of overeating when stressed, are also the ones that are most responsive to a subtle 'nudge' –a cue informing them of the high caloric content of the food– that actually reduces their tendency to (over)eat (see also Fennis, 2017). Indeed, the results of this study show that, when the cue is absent, we replicated the differential effect of stress on hedonic food consumption

[5] Note: a post-hoc analysis of the actual observed effect sizes of the critical interaction for each of the four studies (Experiment 1: $r = .16$, Experiment 2: $r = .14$; Experiment 3: $r = .18$, Experiment 4: $r = .20$, respectively) confirmed that they fell within the range of what Funder and Ozer (2019) label "small" to "medium" effect sizes (or "small" to "typical" according to Gignac & Szodorai, 2016).

[6] Note: converse simple slopes analyses in line with Experiment 2 confirmed that the impact of the caloric cue (present vs. absent) under conditions of stress (high vs. low) was only significant for consumers with a fast LHS ($\beta = -1.13$, $F(1, 88) = 3.89$, $p = .05$, evaluated at $M - 1\ SD$), but not for their slow LHS counterparts ($\beta = .53$, $F(1, 88) = .91$, $p = .34$, evaluated at $M + 1\ SD$).

as a function of LHS. However, when present, fast LHS consumers responded to stress similarly as their slow LHS counterparts attenuating the stress-eating link.

7.1. Limitations and future research directions

In Experiment 1, 2 and 4, we gauged the tendency for hedonic consumption using scenario-based tasks, While the results of these studies converged with those of Experiment 3, which measured actual eating, such scenario tasks are inherently limited, since they rely on individuals' imperfect imagination skills, and the extent to which people are aware of their consumption choices under the given conditions, and willing and/or able to express these (see Nisbett & Wilson, 1977). Hence, future research may aim to replicate and extend the present findings by supplementing these explicit measures with implicit ones, such as a Mouse Tracker task (e.g., Schoemann et al., 2020), Food IAT (Richetin et al., 2007) or Food Stroop task (e.g., Demos et al., 2013). Moreover, future research might also extend the present findings using more ecologically valid choice contexts. For example, the tendency to select and acquire hedonic foods under the given conditions might also be gauged using mobile eye-tracking with 'real' consumers in an actual supermarket, monitoring their relative visual attention for certain (palatable) target foods while taking into account their reported hunger levels, and registering the actual monetary amount spent on them.

The present studies used a stress-inducing task adapted from the Montreal Imaging stress task (Acar-Burkay & Cristian, 2019) and a reading task featuring a news article describing the likelihood of serious stressors such as disease risk, economic downturns and job loss (cf. Griskevicius et al., 2011, 2013). While both tasks are typical of the stress tasks used in experimental research, were successful in inducing feelings of stress in this and previous research, and their effects converged across studies, this leaves open the question whether the effects would generalize to other types of stressors and stress tasks. More specifically, while the first task may pertain to *performance* stress and the second one to *outcome* stress, it remains an open question whether the present findings would also generalize to the stress experienced by many as a function of 'daily hassles' (Lazarus & Folkman, 1984), such as overtaxed, or frustrated daily schedules, daily experiences of unpredictable, (mildly) aversive events (e.g., traffic jams, out of stuck products, foregone opportunities), or workplace pressures (see also Duhachek, 2005). Moreover. for the math task, we instructed participants not to make use of paper, pencil or calculator. However, since most studies were conducted online, this could not be verified except in Experiment 3. Of course, to the extent it was a problem, it was probably approximately similar across all online studies. Nevertheless, future online studies may want to include at least some checks assessing whether people followed this instruction. In addition, we used self-reported stress as a manipulation check. Future research might extend this measure by using implicit psychometric measures and/or psychophysiological measures that combined may offer more substantive evidence for the success of the manipulations used.

In addition, a limitation of the present research is its focus on acute stress. Hence, future research might examine whether the present effects are also observed when focusing on the role of chronic, rather than acute, stress. While individual differences in LHS mainly shape how acute stress induces differential self-regulatory behavioral repertoires in response to a given stressful stimulus or event (rather than differential receptivity to stress per se, as our data also show), that may be fundamentally different for *chronic* stress. Indeed, there are strong indications that the level of chronic, rather than acute stress *does* vary across the fast-to-slow LHS continuum (Figueredo et al., 2006; van der Linden et al., 2018). Examining the long-term consequences of such chronic stress for consumers' dietary behavior as a function of LHS my thus constitute an interesting avenue for future research.

Moreover, In the present series of studies we used a validated, but also highly condensed measure to assess individual differences on the fast-to-slow LHS continuum –the Mini-K (Figueredo et al., 2006; Richardson et al., 2017), next to the more elaborate, 42 item K-SF-42. While efficient and showing predictive validity in the present studies, these individual difference measures are not without their problems. As already noted, the Mini-K is known for possessing low reliability (see Figueredo et al., 2017), which was a key reason we turned to the K-SF-42 in Experiment 2. In addition, the use of psychometric measures assessing individual differences in life history strategies has also been critiqued on various grounds, ranging from the presumably unwarranted extrapolation of inter-species to intra-species (inter-individual) trait covariation, and questionable construct validity (e.g., approaching LHS as a proximate, rather than ultimate construct), to their dimensionality, ostensibly eclectic selection of items, and confining the fast-to-slow continuum to lifestyle factors without taking into account more objective life history events (see e.g., Copping et al., 2014; Gruijters & Fleuren, 2018; Richardson et al., 2017; Zietsch & Sidari, 2020). Hence, future research may be well advised to use these measures prudently. One way to move forward is to use triangulation, supplementing LHS questionnaires with e.g., biomarkers that tend to associate with the fast-to-slow continuum (e.g., puberty onset, or sexual activity onset, see e.g., Copping et al., 2014). Alternatively, psychometric measures may be supplemented by validated environmental indicators of (childhood) unpredictability, for example using the Fragile States Index (Fund for Peace, 2021), which records per year the extent across various dimensions to which one's living conditions (at the state level) are stable and well resourced, or, conversely, conflict and unpredictability ridden and resource scare. Such an approach may provide more converging psychometric evidence for the validity of these questionnaires.

Finally, while sensitivity power analyses (Faul et al., 2009: Perugini et al., 2018) indicated that all present studies were adequately powered to observe 'typical' effects of stress on food consumption as documented in previous meta-analyses (see Ferrer et al., 2020), and while the observed effect sizes of our studies were in line with what Funder and Ozer (2019) term 'small to medium' effects, Experiment 3 and 4 clearly had lower power than Experiment 1 and 2. Hence, caution is warranted when making strong inferences based on the findings concerning the role of scarcity and warning cues in the context of the stress-eating link. As noted earlier, these findings should be seen mainly as suggestive and tentative, may shape a future research agenda, and also call for higher powered replication.

Finally, future research might examine whether other cues in addition to scarcity and caloric content may yield similar effects as the amplifying vs stifling effects on hedonic food consumption that the present studies demonstrate. This may aid in more comprehensively mapping the 'playing field' of enhanced vs. reduced hedonic eating among fast LHS consumers and in so doing, also in offering additional tools and suggestions for the development of effective, yet simple, nudges to promote healthy choice and decision making, particularly among these consumers.

CRediT authorship contribution statement

Bob M. Fennis: Conceptualization, Methodology, Formal analysis, Writing – original draft. **Justina Gineikiene:** Writing – review & editing. **Dovile Barauskaite:** Writing – review & editing. **Guido M. van Koningsbruggen:** Writing – review & editing.

Declaration of competing interest

This research was funded by grant no. S-MIP-17-125 from the Research Council of Lithuania awarded to the second author.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.paid.2021.111261.

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