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Title: An appetite for risk? Failure to replicate the effect of hunger cues on risk taking.

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Abstract: Ditto et al. (1996) reported that consumers who are exposed to external hunger cues (i.e., scent of freshly baked cookies) are less sensitive to risk information. That is, consumers exposed to hunger cues are as likely to take risks in situations with a high versus low probability of losing. Yet, this result is often cited as evidence that hunger increases risk-taking. This may be due to the fact that Ditto et al. (1996) observed that hunger cues increased risk-taking in situations with a high chance of losing. We attempted to replicate this specific contrast in two studies. In the first study, the risk measure was in the food domain (like in Ditto et al., 1996) and in the second study it was in the financial domain. Yet, we failed to observe a main effect of exposure to external food cues on risk-taking. In addition, as it is an untested assumption in the literature that external (cookie scent) versus internal (not eating for several hours) hunger cues can be used interchangeably, we also checked for a potential moderation by type of hunger cue. We did not observe such a moderation when the risk task involved food outcomes, but we detect such an effect when it involved financial outcomes. These results suggest that the widely held assumptions that (1) hunger or exposure to hunger cues induce risk taking and that (2) internal and external hunger cues are exchangeable should be revisited.

Dear professor Prescott,

Attached you will find the revised version of our manuscript; “An appetite for risk? Failure to replicate the effect of hunger cues on risk taking.” (FQAP-D-17-00357) for publication consideration in Food Quality and Preference.

We are thankful to have been given the opportunity to revise this manuscript. We found the reviews to be helpful and constructive and are confident that we were able to address them. We feel that the overall quality of the research report has greatly improved by (1) adding an experiment that more cleanly manipulated the presence of internal and external hunger cues and that also failed to replicate Ditto et al. (1996) and by (2) clarifying the assumptions made by prior literature. A detailed description of these improvements can be found below. To organize the revision notes, we used the same headings as the reviewer.

We want to thank you and the reviewer for the insightful suggestions and we hope you find the revised manuscript interesting.

We are looking forward to your response,

Kind Regards,

Anouk Festjens, Sabrina Bruyneel, Siegfried Dewitte.

We found the review to be helpful and constructive and are confident that we were able to address them. We feel that the overall quality of the research report has greatly improved by (1) adding an experiment that more cleanly manipulated the presence of internal and external hunger cues and that also failed to replicate Ditto et al. (1996) and by (2) clarifying the assumptions made by prior literature. A detailed description of these improvements can be found below. To organize the revision notes, we used the same headings as the reviewer.

A. GENERAL ISSUES

The reviewer remarks that he does not agree with our overall conclusion about a failure to replicate. He states that we cannot just rely on a p value to conclude that there is no effect. He also suggests that our effect goes in the same direction as Ditto et al. (1996) and that our figure seems to indicate similar effects. We thank the reviewer for suggesting to give more attention to the pattern in the data. After reconsidering the data in the original figure, we believe that they were reported in a suboptimal manner. That is, the percentages in the original figure reflect the amount of people in each of the conditions willing to play the game of chance divided by the total amount of people willing to play the game. We agree that this provides a misleading picture of our results and we therefore redesigned the figure. The percentages in the new figure reflect the amount of people in each of the conditions willing to play the game of chance divided by the total amount of people in that particular condition. The new figure more clearly demonstrates that there is no main effect of exposure to an external food cue on risk-taking, there are even no tendencies.

Figure 1: amount of people in each of the cells

		hunger absent	hunger present	total
Amount of people that decided to gamble	food cue absent	6	8	14
	food cue present	5	8	13
	Total	11	16	27

Amount of people that decided not to gamble	food cue absent	14	21	35
	food cue present	21	16	37
	Total	35	37	72

The reviewer's remark about the p value also motivated us to further investigate to what extent our null-result was robust. We therefore decided to conduct another (conceptual) replication attempt, with a few changes (see below for a more elaborate motivation).

B. INTRODUCTION

In general, the reviewer asks us to provide more adequate references for the assumptions made by prior literature. That is, we propose that prior literature is built on three false assumptions.

First, we state that the common view is that the findings of the effects of hunger on impulsivity (i.e., hunger increase impulsivity) are perfectly translatable to the risky domain ("hunger increases risk seeking). The reviewer asked to give more references for this common view¹. Yet, this assumption is not crucial for our story. That is why we decided to drop it in the current version of the paper.

Second, Ditto et al. (1996) reported that consumers who are exposed to external hunger cues (i.e., scent of freshly baked cookies) are less sensitive to risk information. That is, consumers exposed to hunger cues are as likely to take risks in situations with a high versus low probability of losing. Yet, this result is often cited as evidence that hunger increases general risk-taking, which is something different. The reviewer asked to provide more references showing that this is indeed the dominant explanation of the findings of Ditto et al. (1996). In the current version of the paper, we addressed this request by copy/pasting the specific phrases that attest our statement from the papers that cited Ditto et al. (1996) and add them as footnotes (see page 4 of the manuscript).

Third, we argue that the assumption that externally and internally generated hunger cues can be used interchangeably is common in the literature. The reviewer asked to provide more adequate references for this common interpretation in the literature. In the current version of the paper, we again decided to address this question by copy/pasting specific phrases that attest this implicit assumption from the papers that we cite (see page 5 of the manuscript). Moreover, we believe

¹ This assumption is implicit in most of the papers on this topic. To illustrate, Ditto et al. (1996) state that: "*Our key prediction was that behavior in the presence of visceral cues would be more 'impulsive,' i.e., less sensitive to risk information, than behavior in the absence of visceral cues.*". Likewise, Jia, Kahn, and Litt (2017) state that: "*For example, it has been shown that lower self-control resulting from proximity to a temptation (Prelec and Bodner 2003, Khan and Dhar 2007), limited cognitive resources (Shiv and Fedorikhin 1999), or 'hot' affective states such as hunger and sexual arousal (Hoch and Loewenstein 1991, Prelec 2004) can lead people to choose options that may put their longterm interest at risk over options that are beneficial in the long run.*" Also, Ariely and Loewenstein (1996) state that a visceral cue increases risk taking (i.e., they focus on a sexual cue but their theory also hold for other visceral cues): "*Consistent with such a prediction, prior research has shown that sexual motivation can distort judgments of the risk of contracting sexually transmitted disease (Blanton & Gerrard, 1997; Ditto, Pizarro, Epstein, Jacobson, & MacDonald, 2005), and that it leads to steeper time discounting in males (Wilson & Daly, 2004).*" We believe that these references "breath" the view that the effects of hunger on impulsivity are translatable to risky choice.

that this assumption deserves more focus in the current version of the paper. Hence, we decided to adapt the additional study in such a way (as compared to the original replication) to more cleanly test this assumption. That is, the first study aimed at testing this assumption (external hunger cue: scent of freshly baked cookies, internal hunger cue: not having eaten for several hours) for a risk task involving food outcomes (cf. Ditto et al. 1996). Yet, because the food outcomes in this study (and in Ditto et al. 1996) may act as an external hunger cue itself, we conducted this second study where we assess the influence of internal and external hunger cues on a risk task involving financial outcomes rather than one involving food outcomes. This study revealed a significant external by internal hunger cue interaction effect (see figure 2) and also failed to replicate the contrast of Ditto et al. (1996) that exposure to external hunger cues increases risk-taking. Even more, we found that hungry individuals will be *less* likely to take (financial) risk but only when being exposed to external hunger cues.

Figure 2: The effect of external and internal hunger cues on financial risk taking (Study 2).

C. METHOD & RESULTS

We included effect sizes for all tests and were more specific about the excluded participants. We also included confidence intervals (using the adjusted Wald technique as we deal with binary data). The reviewer also asked to provide means and standard deviations for the main test on the decision to take the gamble. Yet, we deal with binary (yes/no) data and are unaware how we could report the standard deviations for this particular test.

D. DISCUSSION

We thank the reviewer for pointing out several other references that studied the effect of hunger on risk-taking (i.e., Levy et al., 2013; Symmonds et al., 2010; De Ridder et al., 2014). We included those references in the introduction of the paper, since they strengthen our claim that

evidence on this topic is mixed and the dominant view currently is that hunger increases risk-taking.

See footnote 9 in the manuscript (page 5) for our interpretation of Orquin and Kurzban (2015).

We further believe that the addition of our second study strengthens the main message of the paper, namely that exposure to external food cues does not necessary increases risk-taking. In the revised discussion of the paper, we therefore stress that our *two* studies failed to replicate the contrast of Ditto et al. (1996) that raised a lot of attention in the literature.

We want to thank you and the reviewer for the insightful suggestions and we hope you find the revised manuscript interesting.

We are looking forward to your response.

Highlights

- Ditto et al. (1996) found that external hunger cues decrease sensitivity to risk information.
- This is cited as if hunger increases risk-taking.
- We test whether external versus internal hunger cues influence risk-taking.
- We find no main effect of external hunger cues, but an interaction effect of both cues on risk-taking.

1. Introduction

Hunger seems to have an enormous impact on behavior. To illustrate, hungry consumers seem to be more likely to engage in all sorts of impulsive behaviors such as overeating (Wansink & Chandon, 2014), but also overspending or abandoning difficult cognitive tasks (for a review see Orquin & Kurzban, 2015). Yet, it remains unclear how hunger affects risk-taking behavior. This is a problem because many of our decisions are made in a risky context. Knowing how a visceral state – like hunger – affects them is an important step towards inducing behavioral change. The dominant assumption seems to be that a visceral state leads to more out-of-control, risky behaviors (see Loewenstein 1996 for a seminal work reflecting this view, but also Ariely & Loewenstein, 2006; Jia, Kahn, & Litt, 2017; Levy et al., 2013; Rick & Loewenstein, 2008; Symmonds et al., 2010). This assumption may have been nourished by a handful of studies showing that exposure to hunger (or any “hot” affective state) leads to a lower sensitivity to risk information (Ditto et al., 2006; Rottenstreich & Hsee, 2001). There is, however, a lack of direct empirical evidence testing the effect of hunger on risk behavior.

In one of the few studies on hunger and risk taking, Ditto et al. (2006) provided participants with the opportunity to play a game that would either result in winning chocolate cookies or working on a boring task for an extra 30 minutes. One group of participants saw and smelled the freshly baked cookies while deciding to play the game or not, whereas the others were merely told about the cookies. The risk of losing time was manipulated between-subjects: it was either high (40% chance of losing) or low (20% chance of losing). Although the paper focused on the finding that participants in the hunger (vs. control) cue condition are insensitive to probability information (i.e., people ignore the difference between a 40% vs. 20% chance of losing), the paper is mostly cited as if a visceral state increases risk taking (e.g., Alba &

Williams, 2013¹; Jia, Khan, & Litt, 2015²; Loewenstein, O'Donoghue, & Bhatia, 2015³; Nordgren, van der Pligt, & Van Harreveld, 2007⁴). Indeed, in the high risk condition, 80% in the hunger cue condition vs. 45% in the control condition played the game. We attempted to replicate this contrast that raised a lot of attention in the literature. Remark that in the low risk condition, willingness to play the game did not differ between the hunger cue (85%) and the control condition (95%). We will not repeat this condition.

As the dominant interpretation of the findings of Ditto et al. (2006) seems to discourage further research in this domain, the current paper specifically focuses on the main effect of exposure to hunger cues on risk-taking and seeks to formally replicate it (i.e., replicate the findings of Ditto et al. 2006 in the high-risk condition). Furthermore, we test a boundary condition by investigating whether the effect depends on using an external (i.e., the scent and sight of freshly baked chocolate chip cookies) versus internal (i.e., not having eaten for several hours) hunger cue. Although clearly not identical - external hunger cues signal the presence of food whereas pure internal hunger cues signal the absence of food - the untested assumption that both types of cues can be used interchangeably is common in the literature (Briers et al. 2006⁵; de Ridder et al., 2014⁶; Loewenstein, 1996⁷; Nordgren, van der Pligt, & van Harreveld, 2007⁸;

¹ “... For example, consumers are willing to undertake riskier behaviors to obtain products they are craving when under the influence of a visceral drive than when in a neutral state (Ditto et al. 2006)...”

² “...hot affective states such as hunger and sexual arousal can lead people to choose options that put their interest at risk...Such deleterious decisions may not transpire simply because people ignore risks when self-control falters under the grips of temptation (Ditto et al., 1996). Rather, lower self-control may actually distort how risky people perceive their courses of action to be.”

³ “... Just as our model predicts that increased affective intensity for cookies will increase the monetary certainty equivalent, it also predicts that increased affective intensity for cookies will make people more likely to accept the gamble over an outside option. This is exactly what is found by Ditto et al. (2006)...”

⁴ “... These findings add to a number of studies that have shown that visceral states can influence health beliefs (Ditto et al. 2006)...”

⁵ Briers et al. (2006) use olfactory food cues and hunger interchangeably across their studies and report: “Exposure to an olfactory food cue is known to increase craving for the cued food.”

⁶ De Ridder et al. (2014) argue that appetite for food and hunger will lead to similar motivational effects. See also: “...In three studies we tested the hypothesis that hot states promote advantageous decision with uncertain long-term outcomes by manipulating hunger or appetite as a typical hot state that is characterized by a strong visceral drive. The objective of Study 2 was to replicate the findings from Study 1 by employing a more subtle manipulation of a hot state by increasing appetite for food, ruling out potentially physiological effects of hunger that may interfere with our aim to manipulate hot states....”

Orquin, & Kurzban, 2015⁹; Rick & Loewenstein, 2008¹⁰). The first study aims at testing this assumption (external hunger cue: scent of freshly baked cookies, internal hunger cue: not having eaten for several hours) for a risk task involving food outcomes (cf. Ditto et al. 1996). Because the food outcomes in this study (and in Ditto et al. 1996) may act as an external hunger cue itself and therefore distort the findings, we conducted a second study where we assess the influence of internal and external hunger cues on a risk task involving financial outcomes rather than one involving food outcomes.

2. Study 1

As in Ditto et al. (2006), we asked participants whether they were willing to play a game that would either result in winning cookies (60% chance) or working on a boring task (40% chance). We manipulated whether participants could see and smell the cookies while deciding to play the game and whether they were hungry.

2.1. Method

2.1.1. Participants

One-hundred-and-nineteen undergraduate students (58% women) came to the lab to participate in the study in exchange for a participation fee or course credit. Their ages ranged from 17 to 40

⁷ Loewenstein (1996) reports that the sight, smell, sound, or feeling of a desired object induces the same visceral cravings like hunger or thirst.

⁸ Nordgren, van der Pligt, and van Harreveld (2007) do not pay attention to the potential different impact of internally versus externally induced hunger: "...Participants in the hunger condition were instructed not to eat for at least 4 hr prior to participation in the study. To further induce hunger, a bag of freshly popped popcorn was placed (out of view) in the cubicle where participants performed the study..."

⁹ In a meta-analysis on the effect of blood glucose levels on decision making, Orquin and Kurzban (2015) list both physiological hunger and external food cues as valid manipulations of blood glucose levels. This implicitly means that no differences between both manipulations is assumed.

¹⁰ "...The food industry is particularly motivated to capitalize on immediate emotions. Mrs. Field's Cookies, for example, has been known to pump enticing cookie smells into the atmosphere of shopping malls to stimulate hunger. A company named "ScentAir" sells similar odors (e.g., "Glazed Donut," "Iced Cinnamon Pretzel," "Blue Cotton Candy") to businesses looking to stimulate hunger..."

years old ($M = 18.91$, $SD = 2.62$). The study used a 2 (internal hunger level: high vs. low) x 2 (external hunger cue: present vs. absent) between-subjects design.

2.1.2. Internal hunger manipulation.

All participants received an instruction email 24 hours prior to the experiment. Participants in the “hunger level high” [“hunger level low”] condition were instructed to not eat for at least four hours [to eat a full meal within an hour] prior to the study (Nordgren, van der Pligt, & van Harreveld, 2007).

2.1.3. Preliminary questions.

Upon arrival in the lab, participants were told that they would be participating in a study on risk perception. After signing a consent form, participants completed a demographic questionnaire and the Positive and Negative Affect Scale (PANAS). Participants then completed ten items from the Raven’s Progressive Matrices Test, a cognitive task in which the participant are presented with a series of visual patterns, and attempts to determine the rules by which the patterns change. Note that all these procedures were identical to the ones used in Ditto et al. (2006).

2.1.4. Gambling task.

Next, participants were told that they had the opportunity to play a game of chance. Participants were informed that because gambling for money was not possible in a laboratory setting, cookies would be used as the reward. The game involved randomly selecting one card from a set of 10 (six winning cards). It was explained that, if they chose a winning card, they would be given the opportunity to eat as many cookies as they liked and their participation in the study would be complete. However, if they chose a losing card, they would receive no cookies, and would have

to remain in the lab and complete an extra 30 minutes of matrices problems (in reality the task took about 10 minutes). Participants could also decide to not play the game. In this case, they received no cookies and were not asked to complete additional matrices problems. At this point, participants indicated their choice, and completed a post-choice questionnaire (described below).

2.1.5. External hunger cue manipulation

Orthogonal to the internal hunger manipulation, half of the participants was randomly assigned to an “external hunger cue absent” condition, and the other half to an “external hunger cue present” condition. In the former condition, participants were just informed that they had the chance to win cookies. In the latter condition however, participants arrived to a laboratory filled with the aroma of freshly baked cookies¹¹ and all measures were completed in the presence of the cookie scent. A batch of cookies was also placed on each of the tables as participants completed the questionnaires.

2.1.6. Dependent measure and post-choice questionnaire

The primary outcome of interest was whether participants chose to take the gamble in order to win the cookies. Participants were also given a post-choice questionnaire including a number of items measuring participants’ perceptions of the desirability and likelihood of the possible outcomes. First, participants were asked to indicate how much they [dis]liked eating chocolate chip cookies on a 9-point scale (9 = very much), and how much they [dis]liked completing the Raven’s Progressive Matrices problems (9 = [dis]like very much). Second, participants were asked to indicate how much they expected to [dis]like eating the cookies in case of winning (9 = [dis]like very much), and how much they expected to [dis]like completing the matrices problems

¹¹ The cookies were baked in a small oven located inside the room.

in case of losing (9 = [dis]like very much). Third, they were asked to indicate how likely they believed they were going to win and lose in the game (9 = extremely likely). Finally, participants were asked to indicate the time of their last meal, the degree to which they felt hungry (7 = totally hungry) and were on a diet (9 = totally yes). They also indicated which of the two instruction emails they received and whether they read it.

2.2. Results

2.2.1. Data preparation

We removed the observations of 20 participants who indicated not to have read or complied¹² with the (not) eating instructions¹³. The final dataset thus consisted of 99 participants.

2.2.2. Decision to play the game

The effects of the two experimental manipulations on participants' likelihood of choosing to play the game was analyzed with logistic regression. The results revealed no main effect of the cookie manipulation ($\text{Wald}(1) = .21, p = .65$) or the hunger level ($\text{Wald}(1) = 1.27, p = .26$). There was also no hunger level by cookie manipulation interaction ($\text{Wald}(1) = .87, p = .35$).

The percentage of participants willing to take the gamble in absence of the food cue was 28% in the hunger level high (95% CI [15%, 46%]) and 30% in the hunger level low (95% CI [14%, 52%]) condition. When the food cue was present, 33% of participants (95% CI [18%, 53%]) was willing to gamble when hungry and 19% (95% CI [8%, 38%]) when satiated.¹⁴

¹² Participants in the “hunger level high” [“hunger level low”] condition who consumed a meal < 4 hours [> 1 hour] prior to the study and the ones who indicated not to have read the instruction email. The results were similar if these observations were not removed.

¹³ The excluded observations were divided across the four conditions as follows: hunger level low & food cue absent: $n = 5$, hunger level low & food cue present: $n = 5$, hunger level high & food cue absent: $n = 7$, hunger level high & food cue present: $n = 3$.

¹⁴ These confidence intervals were computed using the adjusted Wald technique.

Insert figure 1 about here

2.2.3. Results post-choice questionnaire.

A series of 2 (hunger level: low vs. high) x 2 (external hunger cue: present vs. absent) ANOVAs revealed that the hunger and cookie manipulations did not affect the perceived desirability and likelihood of winning the cookies or losing the additional time in the lab (see Table 1). That is, apart from the main effect of hunger on the expected pleasantness of eating cookies in case of gaining ($F(1,95) = 7.77$, $p = .01$, $\eta^2 = 0.076$) and on the expected discomfort of eating cookies in case of gaining ($F(1,95) = 5.68$, $p = .02$, $\eta^2 = 0.056$), all p 's were > 0.05 .

The self-reported hunger level ($M = 5.55$, $SD = 1.23$ vs. $M = 2.26$, $SD = 1.27$, $F(1,97) = 169.72$, $p < .001$, $\eta^2 = 0.636$) and time of the last meal ($M = 10.58$, $SD = 4.24$ vs. $M = 0.33$, $SD = .474$, $F(1,97) = 266.04$, $p < .001$, $\eta^2 = 0.733$) of hungry participants were significantly higher than of satiated ones, indicating that our internal hunger manipulation worked.

Insert table 1 about here

Hunger cues and mood. Participants' mood was examined by summing the scores of the 10 positive [negative] mood items on the PANAS. An ANOVA revealed a main effect of the hunger manipulation on the Positive Affect scale ($F(1,95) = 11.146$, $p = .001$, $\eta^2 = 0.105$), with hungry individuals being less positive ($M = 40.942$, $SD = 1.043$) than sated ones ($M = 43.101$, $SD = 1.071$). None of the other effects were significant (all p 's $> .09$).

3. Study 2

The first study did neither reveal any effect of hunger cues (internal or external) on people's willingness to take risk (to obtain food), nor any difference of an externally versus internally induced hunger state. This may be a consequence of the fact that the outcomes in the risk task were expressed in food terms, which may have acted as an external hunger cue and made a clean test of the interaction effect ambiguous. The second study therefore adopts a cleaner approach by orthogonally manipulating the presence of an external and internal hunger cue (as in study 1) but now testing their effect on *financial* risk-taking. This gives us an additional opportunity to conceptually replicate the findings by Ditto et al. (2006).

3.1. Participants and Design.

3.1.1. Participants

One-hundred-and-twenty undergraduate students (57 women, $M_{\text{age}} = 21.73$) came to the lab to participate in the study in exchange for a participation fee or course credit. The study used a 2 (internal hunger level: high vs. low) x 2 (external hunger cue: present vs. absent) between-subjects design. The dependent variable was financial risk taking.

3.1.2. Independent variables

Internal hunger cue manipulation. We organized all experimental sessions between 8.30 AM - 11.30 AM in the morning and instructed all participants to arrive at the lab without consuming breakfast. To manipulate the level of hunger, participants were randomly assigned to either the sated condition in which they were required to consume a full breakfast (i.e., three LU© breakfast cookies) upon arrival or to the hunger condition in which there was no such requirement. After completing 20 minutes of filler tasks, all participants then completed the focal test, namely risk task.

External food cue manipulation. To manipulate the presence or absence of an external food cue, one group of participants was exposed to a bowl of M&M's during the risk task. We told them that the bowl of M&M's was placed on their desk for an unrelated taste task that would follow immediately after the risk task. We also informed them that they were allowed to snack from the M&M's during the subsequent task. The other group of participants was only presented with the bowl of M&M's after completing the risk task.

3.1.2. Dependent variable

Our risk task measured participants' risk seeking for financial gambles. To measure risk seeking for gain outcome gambles, participants were asked to specify for four different dice games the amount of money they needed to gain to be indifferent between playing the game or not (e.g., "I would be indifferent between gaining ___€ for sure and participating in a dice game with a 50% chance of gaining €40 and a 50% chance of gaining nothing."). The amount of the potential gain varied over the four games (i.e., (€10, 1/2; €0), (€20, 1/2; €0) (€40, 1/2; €0) (€60, 1/2; €0)), and the order of the games was randomized.

3.2. Results

We first computed a risk seeking index for each participant. To obtain this index, we divided each indifference value by the maximum gain of the respective dice game (i.e., €X/€10, €X/€20, €X/€40, €X/€60), and averaged these normalized scores (with 0.5 indicating risk neutrality). We deleted four participants that had an index that was more than three standard deviations away from the mean. The final dataset thus consisted of 116 participants.

We then subjected this risk seeking index to an ANOVA with hunger and external food cue as between-subjects variables. This analysis revealed a main effect of external food cue

($F(1,111) = 8.888, p = .004, \eta^2 = .074$) and an interaction effect of hunger by external food cue ($F(1, 111) = 6.528, p = .012, \eta^2 = .056$). There was no main effect of hunger ($F(1, 111) = 1.477, p = .227, \eta^2 = .013$). Figure 2 visualizes these results. In the presence of the food, the mean risk index of the hungry individuals was .42 (SD = .14, 95% CI [.38, .47]) and of the satiated ones was .53 (SD = .16, 95% CI [.47, .60]). In the absence of the food, the mean risk seeking index of the hungry individuals was .58 (SD = .15, 95% CI [.53, .64]) and of the satiated ones was .54 (SD = .17, 95% CI [.49, .60]). We also computed all contrast effects. We found that hungry (vs. satiated) individuals were *less* risk-taking in the presence of food ($F(1, 111) = 6.85, p = .01$), but equally risk-taking in the absence of food ($F(1, 111) = .93, p = .34$). Moreover, the presence (vs. absence) of food *decreased* risk-taking when individuals were hungry ($F(1, 111) = 17.39, p = .00$), but not when they were satiated ($F(1, 111) = .08, p = .78$). Overall, these results show that there is no main effect of exposure to food cues on financial risk-taking and that internal and external hunger cues generate different effects.

 Insert figure 2 about here

4. Discussion

The current article aimed at replicating the well-cited finding of Ditto et al. (1996) that hungry individuals take more risk to obtain food (when chances of losing are high). This replication attempt failed. In study 1, we observed that decision-makers exposed to external hunger cues (i.e., cookie scent) were as likely to take risk to obtain food as the ones who were not (Study 1). In study 2, we observed that there was no main effect of exposure to external hunger cues (i.e., physical presence of a bowl of M&M's) on financial risk taking. Even more, we found that the presence of food *decreased* financial risk-taking when individuals were hungry. In sum, across

two studies with more than 200 participants based on consequential and well-established lab procedures, we did not find any evidence that (external) hunger cues induces higher risk taking, thereby providing evidence that the findings by Ditto et al. (2006) may be less reliable than usually assumed. Neither did internal or ‘real’ hunger cues increase risk-taking. If anything, showing food to hungry participants decreased their risk taking.

The latter finding highlights the second goal of this article: testing the commonly held assumption that external (e.g., cookie scent) and internal (e.g., not eating for several hours) hunger cues lead to similar effects on (risk) behavior. We found no evidence that this assumption would not hold in a setting where the outcomes of the risk task are expressed in food terms (Study 1), but we found conflicting evidence in a setting where the outcomes of the risk are expressed in non-food (i.e., financial) terms (Study 2). That is, the effect of exposure to food on financial risk-taking was dependent on the internal hunger state of the decision maker. This latter result suggests that researcher may want to be more careful if they generalize findings obtained with external hunger cues to statements about internal hunger cues and vice versa.

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Table 1: The means (and standard deviations) of each dependent variable in each of the four experimental conditions.

	food cue absent		food cue present	
	hunger level low	hunger level high	hunger level low	hunger level high
1. Liking of eating cookies	6.50 (1.878)	6.31 (1.775)	6.42 (1.748)	6.63 (1.583)
2. Liking of Raven task	4.60 (2.186)	4.62 (1.588)	5.00 (1.939)	4.33 (1.633)
3. Disliking of eating cookies	2.85 (1.565)	2.31 (1.417)	2.92 (1.958)	2.21 (1.933)
4. Disliking of Raven task	5.00 (2.248)	5.24 (2.132)	5.00 (2.098)	5.71 (1.876)
5. Expected liking of eating cookies if gain	6.00 (1.747)	6.76 (1.618)	6.23 (1.861)	7.33 (1.308)
6. Expected liking of Raven task if loss	6.80 (2.016)	7.07 (1.926)	7.00 (1.833)	7.46 (1.351)
7. Expected disliking of eating cookies if gain	3.05 (1.849)	2.17 (1.256)	3.08 (2.096)	2.25 (1.824)
8. Expected disliking of Raven task if loss	7.05 (1.877)	7.28 (2.086)	7.50 (1.058)	6.88 (1.895)
9. Expected likelihood of winning	4.50 (1.433)	4.69 (1.713)	5.12 (1.395)	4.83 (1.689)
10. Expected likelihood of losing	5.50 (1.395)	5.41 (1.823)	5.19 (1.550)	5.12 (1.650)

Figure 1

Figure 1: The effect of the external and internal hunger cue manipulation on the decision to gamble.

Figure 2

Figure 2: The effect of the external and internal hunger cue manipulation on financial risk-taking.