# The adaptive eater: Perceived healthiness moderates the effect of the color red on consumption

Leonie Reutner[1*], Oliver Genschow[2], Michaela Wänke[3]

[1]University of Basel, [2]Ghent University, [3]University of Mannheim

*Corresponding Author:
Leonie Reutner
Department of Psychology
University of Basel
Missionsstrasse 64a
4055 Basel
Switzerland
+41 61 267 06 26
leonie.reutner@unibas.ch

Oliver Genschow
Department of Experimental Psychology
Ghent University
Henri Dunantlaan 2
9000 Gent
Belgium
Oliver.Genschow@UGent.be

Michaela Wänke
Department for Consumer Psychology
University of Mannheim
Parkring 47
68131 Mannheim
Germany
michaela.waenke@uni-mannheim.de

Abstract

Previous studies suggest that the color red reduces food intake because it signals danger and hence acts as a consumption-stopping cue. We demonstrate that this effect cannot be generalized to just any kind of food. Consequently, we show that the color red—despite eliciting similar associations—affects behavior more strongly with regard to unhealthy (potentially harmful) food compared to healthy food. Specifically, the color red more strongly influenced the amount of unhealthy food intake (Study 1) and the choice of unhealthy food options (Study 2) compared to healthy food. Study 2 further demonstrated that the impact of color on behavior decreases gradually as food options become healthier. Moreover, the effect can be observed for subtle (Study 1) as well as salient (Study 2) color cues. These results suggest that consumers do not react in a generalized but in an adaptive way to the color red.


*Keywords:* color, consumption, food, healthiness, psychology

The adaptive eater: Perceived healthiness moderates effect of the color red on consumption

## 1. Introduction

Consumption behavior is far from being exclusively driven by preferences and behavioral intentions. Even subtle environmental cues have been shown to influence how much individuals eat and drink (for a review, see Wansink, 2004). Recent research suggests that the color red can act as an environmental consumption-stopping cue. Specifically several recent studies have demonstrated that the color red reduces the intake of different varieties of food (Bruno, Martani, Corsini, & Oleari, 2013; Genschow, Reutner, & Wänke, 2012, for a review, see Piqueras-Fiszman & Spence, 2014). In light of this, it might be tempting to draw the generalized conclusion that red reduces the intake of any kind of food. However, we argue that this conclusion would be premature. The aim of the present research hence is to test the generalizability of the effect and to demonstrate that avoidance reactions followed by a red environmental cue are food dependent. That is, by considering individuals as "adaptive eaters", whose behavior is influenced by color cues when they are helpful, but remains unaffected when they are not, we assumed that red affects consumption behavior of unhealthy food more strongly than that of healthy food.

### 1.1. Red as a signal for danger and stop

There is more to color than meets the eye. An abundance of recent research has demonstrated that color profoundly affects affective, cognitive, and behavioral responses in humans (for a review, see Elliot & Maier, 2014). This is because color can convey meaning and thereby act as an environmental signal. The color red, for example, is predestined to act as a signal due to its high visibility in the environment. Because of this, it is often used in our society to signal danger and stop (stop signs, red traffic lights, alarms, etc.). These learnt associations have proven to be extremely powerful. More concretely, in response to danger associations, red color cues in the environment have been shown to induce avoidance reactions across various situations, ranging from cognitive performance (Elliot, Maier, Binser, & Friedman, 2009; Elliot, Maier, Moller, Friedman, & Meinhardt, 2007; Mehta & Zhu, 2009) to consumer and health behavior (Bellizzi & Hite, 1992; Gerend & Sias, 2009; Mehta & Zhu, 2009), including food and drink intake (Bruno et al., 2013; Genschow et al., 2012). With regard to food and drink intake, Genschow and colleagues (2012) demonstrated that red color cues on plates and cups reduce consumption quantities of snack food and soft drink intake. More specifically, fewer pretzels were consumed from red plates compared to white or blue plates and a lesser amount of various soft drinks was consumed from red labeled cups compared with blue labeled cups. Recently, these findings have been corroborated and extended to popcorn and chocolate consumption (Bruno et al., 2013). Moreover, Bruno and colleagues also demonstrated that the effect is *not* due to differing contrasts of plates and food, again supporting the conclusion that avoidance reactions were in response to red induced associations with danger and stop. From this, it is tempting to draw the generalized conclusion that the color red would always lead to avoidance reactions and thereby reduce food and drink intake of any variety. However, we argue that avoidance reactions in response to red would not always be adaptive.

**1.2. Red as an (non-)adaptive stop signal**

The consumption context presents a good example of how red induced avoidance would not always be adaptive. On the one hand there are several examples of how red can be a useful signal for danger and threat. Many poisonous berries such as Holly, Daphne, or Castor plants are red. On the other hand, it has been argued that the visual system developed sensitivity to red because ripe fruits are especially nutritious and therefore more likely to be eaten (Dominy & Lucas, 2001; Schaefer, 2006; Wheelwright & Janson, 1985). Given that nature uses red to signal both edibility and inedibility, a general avoidance of red would hence be dysfunctional. In other words, avoidance as a response to the color red would only be functional and adaptive in the case of unbecoming or unhealthy food but not in the case of becoming and healthy food. It might seem plausible therefore that red developed as a signal to alarm and alert the system in a way that would not always result in avoidance reactions. However, because the reactions to color cues are thought to be highly automatic and performed outside of conscious awareness (Elliot et al., 2007; Elliot & Maier, 2007; Genschow et al., 2012; Moller, Elliot, & Maier, 2009; Pravossoudovitch, Cury, Young, & Elliot, 2014), there remains a somewhat puzzling question: Under what circumstances does red lead to avoidance and under what circumstances does it not?

Indeed this question has arisen in color research before. Literature outside of the consumption context has argued that context specific associations determine what kind of meaning the color red conveys and whether it leads to approach or avoidance (Elliot, Maier, Binser, Friedman, & Pekrun, 2009; Elliot, Maier, Moller, Friedman, & Meinhardt, 2007; Elliot & Maier, 2007; Elliot & Maier, 2014). For example, while in mating contexts red is associated with love and passion and thus elicits approach behavior (Elliot et al., 2010; Elliot & Niesta, 2008), red is associated with negative outcomes and failure (red pens mark mistakes) in achievement contexts leading to avoidance behavior (Elliot et al., 2007; Elliot, Maier, Binser, & Friedman, 2009; Elliot & Maier, 2007; Maier, Elliot, & Lichtenfeld, 2008). In this vein, red has been found to impair performance on different intellectual tests, such as IQ tests, supposedly, because red is associated with failure (Elliot et al., 2007). These associations, however, are very specific and therefore limited to very few contexts in which red is indeed directly linked to something that is part of that context (e.g., the red pen in the achievement context). Moreover, the fact that the color red has been shown to lead to avoidance in very different contexts (cf., Chien, 2011; Genschow et al., 2012; Gerend & Sias, 2009; Magee, 2012; Moller et al., 2009), ranging from cognitive performance (Elliot et al., 2009, 2007; Mehta & Zhu, 2009) to consumer and health behavior (Bellizzi & Hite, 1992; Gerend & Sias, 2009; Mehta & Zhu, 2009) including food and drink intake (Bruno et al., 2013; Genschow et al., 2012), makes it somewhat unlikely that such specific negative associations with red should have existed in all of these contexts. This notion is in line with research showing that, based on its extremely prevalent association with danger in our society (e.g., stop signs, alarm signals, red traffic lights), red is *generally* (independent of a context) associated with negative things such as danger and stop (Genschow et al., 2012; Moller et al., 2009; Pravossoudovitch et al., 2014). Moreover, research has shown that the color red is also more strongly associated with negative things (such as danger) than with positive things (such as love)(Genschow et al., 2012; Mehta & Zhu, 2009; Pravossoudovitch et al., 2014). In other words, we automatically show avoidance reactions because society has taught us to associate red most strongly with danger and threat.  From this argument, one might conclude that, because red automatically elicits associations with danger and stop, red color cues should reduce food-intake for every food option, even though avoidance might not always be adaptive. However, we argue that this conclusion may be premature based on one central factor, which has been neglected so far in color research - namely individuals' motivational predisposition towards different food options.

**1.3. Red induced avoidance and motivational predisposition**

Independent of specific contexts, for studies in which red induced avoidance behavior, avoidance was always a means of dealing with a potential threat: The threat of failing in a cognitive achievement test (Elliot et al., 2009, 2007; Mehta & Zhu, 2009), the threat of making costly mistakes in high-involvement decisions (Bellizzi & Hite, 1992), the threat of severe illness when not following health recommendations (Gerend & Sias, 2009), or the threat of weight gain or potential health risks when overconsuming unhealthy snack food or soft drinks (Bruno et al., 2013; Genschow et al., 2012). Hence one could argue that individuals may have been motivated to perform avoidance behavior and that avoidance behavior would be an adaptive response. To illustrate this, consider the food and drinks used in studies showing that red environmental cues lead to a reduction in consumption: Pretzels, popcorn, chocolate and soft drinks are all unhealthy, and thereby represent stimuli that many people aim to avoid. If so, the danger signaled by the color red would match a motivational predisposition to avoid unhealthy food. In other words, the danger signal would fall on fertile ground and should more easily translate into actual behavior. In contrast, people are generally less motivated to decrease their intake of healthy food; they may even want to increase it. Consequently, with regard to healthy food, the activation of color-induced avoidance associations would not be met with similar motivational preparedness and should therefore be less likely to elicit actual avoidance behavior. Evidence for this comes from research showing that subtle signals other than color only affect behavior when the recipient is motivationally inclined to perform that behavior (Winkielman, Berridge, & Wilbarger, 2005). Thus, one could argue that red should be more likely to elicit avoidance behavior when consumption poses a potential risk to one's health and should hence be avoided (i.e., unhealthy food) than when there is no reason for avoidance (i.e., healthy food).

In sum, while it has been proposed that the context shapes what associations the color red activates (Elliot & Maier, 2012; Elliot & Niesta, 2008; Elliot et al., 2010), we argue—in line with the idea of a general activation of avoidance associations in response to red (e.g., Moller et al., 2009; Pravossoudovitch et al., 2014)—that red elicits avoidance associations independent of whether unhealthy or healthy food is present. Different from any previous research, however, we propose that even though the color red automatically activates associations with danger and stop, individuals' motivational predispositions determine adaptive responses. More specifically, we assume that red color cues lead to avoidance behavior more for unhealthy than for healthy food.

## 2. Overview of the experiments

We first conducted a pretest to test whether the color red elicits the same avoidance associations for healthy as well as for unhealthy food stimuli. In a second step, we conducted two experiments to test our hypothesis that consumers react adaptively to environmental color cues and that hence red would lead to less avoidance behavior with regard to healthy compared to unhealthy food. In Study 1 we investigated incidental consumption of healthy and unhealthy food from red and white plates. Color was to be manipulated as an unobtrusive environmental cue outside of focused attention. To broaden our understanding of the situations in which color can influence consumption, we changed the role of color in Study 2 to a salient eye-catcher: Participants had to choose between pieces of bread marked with little green and red flags.

## 3. Methodology

### 3.1 Pretest

In a first step, we conducted a pretest to test whether associations with red would indeed be similar independent of whether red was associated with healthy or unhealthy food. Because we predicted a null-effect, we performed a power analysis using g*power (Faul, Erdfelder, Lang, & Buchner, 2007) to determine the sample size needed to find a small to medium effect ($d$ =.4) with sufficient power (.80) if, contrary to our hypothesis, it existed. Consequently, 196 participants (166 females, $M_{\text{age}}$ = 25.14, SD = 6.50) were recruited to participate in a short online study. Six participants were excluded because they were identified as red-green color blind in a test at the end of experiment (see Ishihara, 1943). Our final sample consisted of 190 participants (162 female) with a mean age of ($SD$ = 6.55).

Participants were shown five pictures of either unhealthy food (chocolate, French fries, chips, a muffin, jelly sweets) or healthy food (grapes, carrot sticks, cucumber slices, an apple, fruit salad). Each picture was presented for four seconds and had a red frame around it. The same shade of red was subsequently used in Study 1 (see the method section of Study 1 for the specific color parameters). After that, participants were asked to list three spontaneous associations with the color of the frame. Two independent raters coded the answers for threat related associations (e.g., danger, warning, stop; Cohen's κ = .93, discrepancies resolved by discussion). Since love and romance are also commonly associated with red, they were coded as well (e.g., love, passion, romantic; Cohen's κ = .90, discrepancies were resolved by discussion). In line with previous research (Genschow et al., 2012; Mehta & Zhu, 2009; Pravossoudovitch et al., 2014), participants spontaneously generated significantly more threat related associations ($M = .69$, $SD = .92$) than romance related associations ($M = .37$, $SD = .54$), $t(187) = 4.29$ , $p < .001$, $d = .42$, indicating that spontaneous threat associations were generally stronger than romance related associations. Importantly, however, neither threat related associations ($M_{unhealthy} = .73$, $SD = .96$ versus $M_{healthy} = .65$, SD = .65, $t$ <1) nor romance related associations ($M_{unhealthy} = .42$, $SD = .56$, versus $M_{healthy} = .33$, $SD = .51$, $t(186) = 1.19$, $p = .236$, $d = .17$) differed according to the healthy or unhealthy food condition.

In a second step, we asked how much participants associated the color with threat and romance respectively. To assess threat related associations, participants indicated on a seven-point scale ranging from 1 (*not at all*) to 7 (*very much*) how much the items "danger", "stop", "caution", and "warning" (Cronbach's α = .92) apply to the color red. To assess romance related associations, participants indicated on a seven-point scale ranging from 1 (*not at all*) to 7 (*very much*) how much the items "love", "romance" and "passion" (Cronbach's α = .78) apply to the color red. Neither threat associations ($M_{healthy} = 4.59$, $SD = 1.68$ versus $M_{unhealthy} = 4.55$, $SD = 1.81$) nor romance associations ($M_{healthy} = 4.70$, $SD = 1.32$ versus $M_{unhealthy} = 4.63$, $SD = 1.40$) differed in the healthy versus unhealthy food conditions, $t$s <1. From this, it can be concluded that the color red carried the same meaning in the presence of healthy and unhealthy stimuli and that any change in consumption behavior would depend on how this meaning translates to the different stimuli (healthy versus unhealthy food).

A manipulation check at the end of the experiment confirmed that the unhealthy food items ($M = 1.79$, $SD = .60$) were indeed perceived to be less healthy than the healthy food items ($M = 6.10$, $SD = .74$), $t(188) = 44.18$, $p < .001$ , $d = 6.40$).

**3.2. Study 1**

As expected, the pretest demonstrated that independent of the food's healthiness, individuals generally associate the color red with threat. That is to say, associations with threat are not influenced by the context. However, we argue that depending on the context these associations have very different behavioral implications. More specifically, we aimed to test the hypothesis that individuals adaptively react to the color red and that the color red would hence have a stronger impact in a potentially harmful or risky situation (i.e., in the presence of unhealthy food) compared to a situation absent of potential risk (i.e., in the presence of healthy food). More concretely, we hypothesized that participants would eat less from a red plate than from a white plate when the served food was unhealthy (i.e., chocolate) but that this reduction would be less pronounced when the food was healthy (i.e., grapes).

### 3.2.1 Method

**3.2.1.1 Participants and Design.** In order to test our hypothesis, we conducted a study with a 2 (color of plate: red vs. white) x 2 (type of food: dark chocolate pieces vs. dark grapes) between-subject design. In total, 91 psychology students (76 female, 1 undisclosed), aged between 16 and 55 ($M$ = 21.83, $SD$ = 5.12), participated in our study in exchange for course credit and were randomly assigned to one of the four conditions. Out of the 91 participants, six participants were red-green color blind and were hence excluded from the analysis. One participant was excluded because she told the experimenter that she hadn't eaten anything all day and she was extremely hungry. She was identified as the only outlier with her consumption being more than 3.5 standard deviations above the mean on both dependent measures. Two participants were excluded because they either had food allergies or incompatible food preferences (i.e., were vegan) that didn't allow them to snack. The final sample thus consisted of 82 participants (69 = female, 1 undisclosed; $M_{age}$ = 21.93, $SD$ = 5.35). The distribution of females and males in the groups was 18 to 3 (grapes, white plate), 21 to 1 (1 undisclosed; grapes, red plate), 15 to 4 (chocolate, white plate) and 15 to 4 (chocolate, red plate). During each experimental session, between one and six participants simultaneously took part in the study, which was carried out throughout the day from 9 a.m. to 5 p.m.

**3.2.1.2. Material**. We placed exactly ten units of either chocolate or dark grapes on either a red or a white plate. Dark grapes and dark brown milk chocolate squares were chosen because they were comparable in size (both were bite-sized and about an inch in diameter) and color contrast with the plates. The brand name or label was neither visible on the chocolate squares nor on the grapes. Importantly, a pretest had shown that chocolate and dark grapes differed significantly in healthiness ratings, $F(1,19) = 116.25$, $p < .001$, $\eta^2 = .86$, but were comparable in tastiness, $F < 1$. Both grapes and chocolate were readily available in local supermarkets. The plates were identical to those used in Study 2 of Genschow and colleagues (2012). The color of the red plate according to the CIELCh color model was, L = 56, C= 70, h= 33, with “L” referring to “Lightness”, ”C” referring to “Chroma” and “h” referring to the hue of the color (cf. Footnote 1). Consumed units and consumed amount in grams served as dependent variables.

**3.2.1.3. Procedure**. The experimenter noted the exact weight of each plate (containing 10 squares of chocolate or 10 grapes) before the experimental session. Participants were welcomed and seated in separate cubicles to ensure that snacking was not influenced by the snacking behavior of their fellow participants. Following the procedure implemented by Genschow et al. (Study 2), participants solved a filler task while being allowed to snack. More specifically, participants were asked to construe sentences from a set of neutral words (with neither positive nor negative connotations) and to solve a set of neutral anagrams for a total of fifteen minutes. During that period they were allowed to snack from a red or a white plate containing either ten chocolate squares or ten grapes. After the fifteen minutes had passed, the plate was taken from the participants and they were asked to indicate how tasty the consumed food had been on a 7-point scale ranging from 1 (not at all tasty) to 7 (very tasty) and how healthy they thought the food was from 1 (not at all healthy) to 7 (very healthy). Participants were subsequently probed for suspicion and then given a test for red-green color blindness (see Ishihara, 1943). Finally, they were thanked and debriefed. After the participants had left, the experimenter noted the number of chocolate squares or grapes eaten for each participant and weighed each plate.

**3.2.2 Results**

**3.2.2.1 Manipulation check.** None of the participants correctly guessed our hypothesis. Participants perceived grapes to be healthier than chocolate, $F(1,83) = 153.53$, $p < .001$, $\eta^2 = .66$, indicating that our manipulation of healthiness was successful.

**Amount consumed.** Because eating one versus two pieces of chocolate is likely to be different from eating one versus two grapes, due to differences in calories, feelings of satiation, and time to consume, we z-standardized our dependent variables (units eaten and amount consumed in grams) separately for chocolate and grapes (cf., Nolan & Heinzen, 2007). The means, however, are reported here in their unstandardized form for reasons of clarity. To test the hypothesis that red would reduce consumption more for the unhealthy food (chocolate) than for the healthy food (grapes), we followed recommendations by Bobko (1986). That is, we conducted a one-factorial ANOVA with four levels (white plate chocolate, red plate chocolate, white plate grapes, red plate grapes) and set contrast weights at 1, -1, 0.5, -0.5 (see also Rosenthal & Rosnow, 1985). The predicted interaction pattern was significant: Red reduced the consumption more for chocolate than for grapes when analyzing consumed units, $t(78) = 2.24$, $p = .028$, as well as when analyzing the total amount consumed in grams, $t(78) = 2.11$, $p = .038$, (see Table 1 for unstandardized means). Simple effects revealed that the difference in consumption from the red versus white plate was only significant for chocolate, $F_{\text{units}}(1, 78) = 7.25$, $p = .016$, $\eta^2 = .07$; $F_{grams}(1, 78) = 5.95$, $p = .017$, $\eta^2 = .07$, but not for grapes, both $F$s < 1 (cf. Footnote 2).

**3.2.2.2Tastiness Rating.** We also assessed whether color influenced participants' tastiness ratings. Color did not influence perceived tastiness for either chocolate or grapes ($F$s

< 1), thereby lending support to previous findings (Genschow et al., 2012) suggesting that color directly cues behavior without affecting evaluations.

**3.2.3. Discussion**

Study 1 replicated the effects of previous studies in the chocolate condition. Participants ate less chocolate from a red plate compared to a white plate. In contrast, as expected, no effect was observed for the grapes. These findings support the novel assumption that consumers adaptively react to red color cues, with red color cues primarily leading to less consumption for food that may indeed pose a risk to one's health.

So far all studies that found red to reduce food consumption (Bruno et al., 2013; Genschow et al., 2012, Study 1) varied color between participants. However, it is unclear whether color could also guide choice. For example, would people be less likely to take food from a red plate than from the neighboring white/green/blue plate? We expect that this again depends on whether the food to be sampled is deemed as posing a potential risk to one's health. For unhealthy food we expect that people are more likely to avoid red but less so for healthy food. Another question is whether the effect is dichotomous (red either influences consumption behavior or it does not) or whether there are differences in the magnitude of the influence of the color red depending on how unhealthy or healthy the presented food is.

**3.3. Study 2**

Study 2 aimed to corroborate and significantly extend the findings from Study 1 that the color red loses its strength the healthier the associated food options are. By adding a neutral option, we aimed to test whether there is a linear relationship between the influence of the color and the healthiness of food. Therefore, different from Study 1 and from previous studies in color research, Study 2 investigated *choice behavior*, and hence a behavior that is far less incidental compared to snacking. To investigate choice behavior we manipulated color within participants for the first time, thereby making color a salient feature of the task. Additionally, we changed the control color from white to green for the sake of generalizability and added a neutral (i.e., neither especially healthy nor especially unhealthy) food condition. Thereby, we aimed to test the hypothesis that when faced with unhealthy options, participants would be less likely to choose a red-marked than a green-marked option and that this difference would gradually diminish when faced with neutral or healthy options. Of course when switching from a design in which color differed between conditions to a color variation within condition, other factors, which may affect choice of color, have to be ruled out. When it comes to choosing a particular color, it is reasonable to assume that people would choose their favorite color (see Piqueras-Fiszman & Spence, 2014, for a discussion on this). Assuming that preferences differ with regard to different colors, we additionally assessed participants' favorite color to be able to control for this.

### 3.3.1. Method

**3.3.1.1. Material and Design**. To ensure that the food options were maximally similar apart from the difference in healthiness, we used three different types of the same food product, namely bread. In Switzerland, where this study was conducted, people are very aware of the healthiness or unhealthiness of various kinds of bread and children are even taught about it in school Accordingly, a pretest had indicated that white bread was judged as being very unhealthy (significantly below the midpoint of the scale, $t(19) = -3.33$, $p = .004$, $d = 1.53$), whereas mixed-flour bread was judged as neutral (did not differ from the midpoint of the scale, $t < 1$) and brown bread was judged as very healthy (significantly above the midpoint of the scale, $t(19) = 11.90$, $p < .001$. $d = 5.46$). In the actual experiment, the crust was removed and the bread was cut into 1-inch bite-sized cubes. Exactly sixteen pieces of bread were served on a white plate. Each piece was marked with a toothpick, which had either a little red or little green paper flag attached to it. Half of the bread pieces were marked by a red flag and the other half were marked by a green flag (see Figure 1). The sixteen pieces were randomly arranged on the plate. The color of the flags was based on the CIELCh color model used in Study 1. To ensure against possible confounds, the two colors only differed in their hue (h) but not in their Lightness (L) or Chroma (C); red LCh (39.9, 52.8, 29.3), green LCh (40.1, 51.6, 152.8).

Taken together, color was manipulated within participants and healthiness of the bread was manipulated between participants leading to a 2 (color: red vs. green) x 3 (healthiness of bread: healthy, neutral, unhealthy) mixed design.

**3.3.1.2. Participants and Procedure.** Participants were approached in front of a local supermarket and asked whether they would like to take part in a short food sampling and to answer a few questions about the food they had tasted. Those who agreed ($N$ = 150, 92 females; mean age = 47.2, $SD$ = 19.2, aged between 16 and 84) were seated at a table and were asked to choose one of the little bread pieces displayed on a plate. The plate was either filled with sixteen pieces of white bread (unhealthy), mixed-flour bread (neutral) or brown bread (healthy), each of which was marked by a colored flag. Participants were randomly assigned to one of the three healthiness conditions. Color was not mentioned to the participants. After having selected and eaten one of the bread pieces, the experimenter asked a few questions about how tasty the bread was (1 = not at all tasty, 7 = very tasty), and a few other questions (e.g., how intensive they thought the bread tasted, how much they like bread in general) as part of the cover story. To make sure that white bread was indeed perceived as being less healthy than the other two breads, we asked how healthy they thought the bread they had just tasted was (1 = not healthy at all, 7 = very healthy). After that, participants were asked to indicate their favorite color. Lastly, participants were given the same test for red-green color blindness as in Study 1 (see Ishihara, 1943). Finally, they were thanked and debriefed. Out of the 150 participants, seven were identified as red-green color blind and were hence excluded from further analysis. Out of the remaining 143 participants, 21 indicated that their favorite color was red and 11 indicated that their favorite color was green. These participants were excluded because choosing between options that only differed in their color would likely lead to choosing the option of one's preferred color (cf. Footnote 3 for statistical analyses). The final sample thus consisted of 111 (69 females) participants ($M_{age}$ = 45.32, *SD* = 18.72). The distribution of females compared to males was 21 to 15 (unhealthy), 26 to 11 (neutral), and 22 to 16 (healthy).

**3.3.2. Results**

**3.3.2.1. Manipulation check.** As expected, participants' perceptions of healthiness differed for the three different breads, $F(2, 110) = 85.31$; $p < .001$, $\eta^2 = .61$. White bread was judged as less healthy ($M = 2.53$) than mixed-flour bread ($M = 3.32$), $t(108) = 2.66$, $p = .009$, $d = 0.54$; which was judged to be less healthy than brown bread ($M = 6.21$), $t(108) = 9.75$, $p < .001$, $d = 2.33$. This indicates that the healthiness manipulation was successful.

**3.3.2.2. Choice.** Overall, less people chose a bread piece with a red compared to a green flag (45 vs. 66 or 40.5% vs. 59.4%), $\chi^2(1, N = 111) = 3.97$, $p = .046$, showing that these participants tended to avoid the red option. Central to our hypothesis, Linear-by-Linear Association revealed that the avoidance of the color red decreased as the healthiness of the options increased, $\chi^2(1, N = 111) = 4.69$, $p = .030$. This indicates that the avoidance of the red option was highest in the unhealthy condition and lowest in the healthy condition. Out of 36 participants, 26 (72.2%) chose the green option, $\chi^2(1, N = 36) = 7.11$ $p = .008$. This avoidance effect diminished and was statistically non-significant in the neutral condition where 22 (59.5%) participants out of 37 chose the green option, $\chi^2(1, N = 37 = 1.32$, $p = .25)$. In the healthy condition, the effect was non-existent (and, if anything, slightly reversed) with 18 (47.4 %) out of 38 choosing the green option, $\chi^2 < 1.0$ (see Figure 2). The pattern of these results is the same for males and females.

**3.3.2.3. Tastiness Rating.** We also examined participants' tastiness ratings. Consistent with previous studies (Bruno et al., 2013; Genschow et al., 2012), color (red vs. green) did not influence the perceived tastiness of the bread, $F < 1$.

**3.3.3. Discussion**

Study 2 corroborated and extended the results obtained in Study 1. Again, the influence of the color red on behavior was strongest for unhealthy food options but gradually diminished as the food options became healthier. Participants without any clear color preference for one of the presented colors (i.e., their favorite color was neither red nor green) avoided the unhealthy white bread pieces marked by a red flag and instead were more likely to opt for one of the bread pieces marked by a green flag. Our findings lend first evidence to the notion that red can act as an environmental stop cue even in a within-setting, in which color is maximally salient.

## 4. General Discussion

The main goal of the present research was to demonstrate that the color red does not always lead to equally pronounced avoidance reactions even though it elicits associations with danger and stop. With respect to food intake, we aimed to demonstrate that the color red would gradually lose its influence the healthier the presented food options were and that consumers would hence react to color cues in an adaptive rather than an absolute way. Our second goal was to test whether this effect would translate to consumption domains beyond snacking and even to situations where color cues are bold in their presence rather than subtle as in previous research. To address these questions, we conducted two studies that extend previous research in several ways. In two studies, we showed that red acts as a powerful consumption-stopping cue with regard to unhealthy food, but gradually loses its impact when food becomes healthier. Importantly, the pretest suggests that this is the case even though red similarly elicited avoidance associations of “danger” and “stop” in the presence of unhealthy and healthy stimuli. Nevertheless, in Study 1, red plates reduced the amount and likelihood of unhealthy food consumption (chocolate), but not for healthy food consumption (grapes). Further, in Study 1, canapé-style food marked with red flags was avoided when it was perceived as unhealthy (white bread), but less so when it was perceived as neutral (mixed-flour bread) and not at all when it was perceived as very healthy (brown bread) compared to food marked with green flags. While Study 1 concentrated on incidental consumption in which color is presented outside of participants' focal attention, Study 2 employed a setting in which color was very salient by manipulating color within participants. In both studies the color red similarly influenced consumption behavior.

**6.1. Implications, limitations and future directions**

Previous research assumed that the only way in which color could differently affect behavior is by holding different associations in different situations. For example, associating the color red with failure in an achievement context would lead to avoidance whereas associating red with love and passion in a mating context would lead to approach (Elliot et al., 2010; Elliot & Niesta, 2008). Extending these findings, our research demonstrates that color cues can also elicit different behavioral reactions based on the presented food options without changing the color association. Although the color red evokes similar strong threat related associations toward healthy and unhealthy food (cf. Pretest), red elicited avoidance behavior toward unhealthy food only (Study 1 & 2). These results suggest a motivational process underlying the influence of color on consumption. Consumption is only guided by color cues when there is a motivation to avoid the stimulus and hence when avoidance is adaptive (i.e., healthy). We consider this an important contribution to understanding the influence of the color red on various consumption behaviors (i.e., food consumption and food choice), because it demonstrates that consumers do not respond blindly but rather adaptively to color cues.

Furthermore, we would assume that this effect should emerge in other contexts as well: The more risky or threatening a situation is perceived to be, the more impact a red color cue should have on behavior. In a similar vein, the more benign a situation is, the less impact a red color cue should have on behavior. Future research should test the applicability of this novel idea to other contexts, such as risky decision-making with regard to one's health (e.g., smoking, handling hazardous materials) in order to test whether the color red could help to promote a healthy lifestyle beyond food consumption (see also Gerend & Sias, 2009).

It is a fascinating insight that something as small and seemingly inconsequential as a simple color cue can influence consumption quantities and food choice. Previous research has taken great care to keep color cues as incidental and unobtrusive as possible to emphasize the automatic and implicit nature of the color effects. In this respect one might have expected color effects to vanish the more attention is paid to color cues. After all, a piece of bread with a green flag is not any healthier or less healthy than a piece of the same bread with a red flag. Yet, even when color cues were highly salient, participants were still influenced by them. This attests to the robustness of the effect. Guiding other people's food consumption, as for example in weight loss programs, may therefore still be effective without trying to hide the color cue.

With regard to the extendibility of these effects, future research may address the potential effect of the color red on food consumption when different kinds of food are presented at the same time (e.g., a plate filled with chocolates and grapes). Would the consumer neglect the chocolate and opt for the grapes when they are presented on a red plate? Our view of an adaptive consumer would suggest that they would indeed eat more of the healthy snack and less of the unhealthy snack compared to people snacking from a plate of any other color. Of course "healthiness" is in the eye of the consumer. We investigated perceived healthiness rather than actual healthiness. Chocolate and white bread were perceived to be unhealthy by our population. One might expect different results in populations in which chocolate or white bread would be perceived to be healthy.

We argue that red acts as a consumption-stopping cue because it taps into individuals' motivation to avoid unhealthy food. One might speculate whether this motivation might be stronger in women than in men, as women rate weight and appearance as more important than men (Mendelson, Mendelson, & Andrews, 2000) and women's self-esteem is more dependent on their bodies than men's (Lowery et al., 2005). We examined the patterns of results separately for male and female participants and the effect appears consistent across gender. However, our samples were predominantly composed of females and the small number of male participants renders it unreasonable to test for statistically significant gender differences. Future research may address possible gender effects more systematically.

In sum, our results show that red does not induce avoidance behavior with regard to just any kind of food. Instead, for the color red to be used as a consumption-stopping cue, food must be unhealthy in the sense that—when consumed excessively—it might be detrimental for one's well-being. Hence, when it comes to color as an environmental cue, red influences consumption behavior in an adaptive, healthy manner.

**Acknowledgements**

The authors would like to thank Noora Al-Rubai, Manuel Klaus, and Matthias Stutz for their help in conducting the research, as well as Caroline Tremble for language corrections.

**References**

Bellizzi, J. A., & Hite, R. H. (1992). Environmental Color, Consumer Feelings, and Purchase Likelihood. *Psychology and Marketing*, *9*(5), 347–363.

Bobko, P. (1986). A solution to some dilemmas when testing hypotheses about ordinal interactions. *Journal of Applied Psychology*, *71*(2), 323–326. doi:10.1037/0021-9010.71.2.323

Bruno, N., Martani, M., Corsini, C., & Oleari, C. (2013). The effect of the color red on consuming food does not depend on achromatic (Michelson) contrast and extends to rubbing cream on the skin. *Appetite*, *71*, 307–13. doi:10.1016/j.appet.2013.08.012

Chien, Y.-H. (2011). Message framing and color combination in the perception of medical information. *Psychological Reports*, *108*(2), 667–672. doi:10.2466/13.24.PR0.108.2.667-672

Dominy, N., & Lucas, P. (2001). Ecological importance of trichromatic vision to primates. *Nature*, *410*, 363–366. Retrieved from http://www.nature.com/nature/journal/v410/n6826/abs/410363a0.html

Elliot, A. J., Kayser, D. N., Greitemeyer, T., Lichtenfeld, S., Gramzow, R. H., Maier, M. A., & Liu, H. (2010). Red, rank, and romance in women viewing men. *Journal of Eperimental Psychology: General*, *139*(3), 399–417. doi:10.1037/a0019689

Elliot, A. J., & Maier, M. A. (2007). Color and psychological functioning. *Current Directions in Psychological Science*, *16*(5), 250–254. doi:10.1111/j.1467-8721.2007.00514.x

Elliot, A. J., & Maier, M. A. (2012). Color-in-context theory. *Advances in Experimental Social Psychology*, *45*, 61–125.

Elliot, A. J., & Maier, M. A. (2014). Color psychology: effects of perceiving color on psychological functioning in humans. *Annual Review of Psychology*, *65*, 95–120. doi:10.1146/annurev-psych-010213-115035

Elliot, A. J., Maier, M. A., Binser, M. J., & Friedman, R. (2009). The effect of red on avoidance behavior in achievement contexts. *Personality and Social Psychology Bulletin*, *35*(3), 365–375. doi:10.1177/0146167208328330

Elliot, A. J., Maier, M. A., Moller, A. C., Friedman, R., & Meinhardt, J. (2007). Color and psychological functioning: the effect of red on performance attainment. *Journal of Experimental Psychology. General*, *136*(1), 154–68. doi:10.1037/0096-3445.136.1.154

Elliot, A. J., & Niesta, D. (2008). Romantic Red : Red enhances men's attraction to women. *Journal of Personality and Social Psychology*, *95*(5), 1150 –1164. doi:10.1037/0022-3514.95.5.1150

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior*

*Research Methods*, *39*(2), 175–91. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/17695343

Genschow, O., Reutner, L., & Wänke, M. (2012). The color red reduces snack food and soft drink intake. *Appetite*, *58*(2), 699–702. doi:10.1016/j.appet.2011.12.023

Gerend, M. a., & Sias, T. (2009). Message framing and color priming: How subtle threat cues affect persuasion. *Journal of Experimental Social Psychology*, *45*(4), 999–1002. doi:10.1016/j.jesp.2009.04.002

Ishihara, S. (1943). *The series of plates designed as tests for color blindness* (9th ed.). London: H.K. Lewis & Co Ltd.

Lowery, S. E., Kurpius, S. E. R., Befort, C., Blanks, E. H., Sollenberger, S., Nicpon, M. F., & Huser, L. (2005). Body Image, Self-Esteem, and Health-Related Behaviors Among Male and Female First Year College Students. *Journal of College Student Development*, *46*(6), 612–623. doi:10.1353/csd.2005.0062

Magee, R. G. (2012). Impression Formation Online. *Journal of Media Psychology: Theories, Methods, and Applications*, *24*(3), 124–133. doi:10.1027/1864-1105/a000070

Maier, M. A., Elliot, A. J., & Lichtenfeld, S. (2008). Mediation of the negative effect of red on intellectual performance. *Personality & Social Psychology Bulletin*, *34*(11), 1530–40. doi:10.1177/0146167208323104

Mehta, R., & Zhu, R. J. (2009). Blue or red? Exploring the effect of color on cognitive task performances. *Science*, *323*(5918), 1226–1229. doi:10.1126/science.1169144

Mendelson, M. J., Mendelson, B. K., & Andrews, J. (2000). Body-Mass in late adolescence : Is a competence x importance model needed ? *Journal of Applied Developmental Psychology*, *21*(3), 249–266.

Moller, A. C., Elliot, A. J., & Maier, M. A. (2009). Basic hue-meaning associations. *Emotion*, *9*(6), 898–902. doi:10.1037/a0017811

Nolan, S., & Heinzen, T. (2007). *Statistics for the Behavioral Sciences* (1st ed.). New York: Worth Publishers.

Piqueras-Fiszman, B., & Spence, C. (2014). Colour, pleasantness, and consumption behaviour within a meal. *Appetite*, *75*, 165–172. doi:10.1016/j.appet.2014.01.004

Pravossoudovitch, K., Cury, F., Young, S. G., & Elliot, A. J. (2014). Is red the colour of danger? Testing an implicit red-danger association. *Ergonomics*, *57*(4), 503–10. doi:10.1080/00140139.2014.889220

Rosenthal, R., & Rosnow, R. L. (1985). *Contrast Analysis: Focused Comparisons in the Analysis of Variance*. New York: Cambridge University Press. doi:10.1037/0021-9010.71.2.323

Schaefer, H. M. (2006). The role of chromatic and achromatic signals for fruit detection by birds. *Behavioral Ecology*, *17*(5), 784–789. doi:10.1093/beheco/arl011

Wansink, B. (2004). Environmental factors that increase the food intake and consumption volume of unknowing consumers. *Annual Review of Nutrition*, *24*(217), 455–79. doi:10.1146/annurev.nutr.24.012003.132140

Wheelwright, N., & Janson, C. (1985). Colors of fruit displays of bird-dispersed plants in two tropical forests. *American Naturalist*, 777–799. Retrieved from http://www.jstor.org/stable/2461256

Winkielman, P., Berridge, K. C., & Wilbarger, J. L. (2005). Unconscious affective reactions to masked happy versus angry faces influence consumption behavior and judgments of value. *Personality & Social Psychology Bulletin*, *31*(1), 121–35. doi:10.1177/0146167204271309

## Footnotes

[1]Those values are reported according to the LCh color model and correspond to the HSL values reported in Genschow et al. (2012)

[2]We also recorded how much time had passed since participants had last eaten as well as participants' favorite color. Controlling for these variables does not influence the significance of our results. Further, statistically controlling for possible gender effects did not influence the significance of our results.

[3]Because color was the only discerning feature of the bread pieces, we assumed that when participants clearly favored red or green over all other colors, their choice would be guided by the color preference. Indeed, comparing participants whose favorite color was red versus all other participants revealed that choice patterns did differ depending on whether or not red was the participant's favorite color $\chi^2(1, N = 132) = 11.58$, $p = .001$ (there were too few participants to conduct a similar analysis for green as a favorite color). From the participants who indicated that red was their favorite color, a majority of 81% ($n = 17$) chose a piece of bread with a red flag, whereas from all other participants (excluding those who

named green as their favorite color), only 40.5 % ($n$ = 45) chose a piece of bread with a red flag. Including those participants in the main analysis did not alter the pattern of results. It did however reduce the effect below conventional levels of significance ($p_{min}$ =.1). Behavioral patterns were the same for men and women.

Table 1

*Mean amount of grapes and chocolate consumed in units or grams depending on the color of the plate they were served on (with standard deviations in parentheses).*

| | Grapes | | Chocolate | |
|---|---|---|---|---|
| Plate Color | Units | Grams | Units | Grams |
| Red | 3.30 (3.53) | 30.62 (33.80) | **0.89 (1.05)** | **5.47 (6.32)** |
| White | 3.33(3.80) | 28.48 (33.09) | **1.89 (1.33)** | **11.42 (7.94)** |

*Note.* Bold numbers within a column indicate a significant difference between the standardized means with $p < .05$.

*Figure 1*. A plate containing 16 pieces of white bread (unhealthy condition) marked with red and green flags.

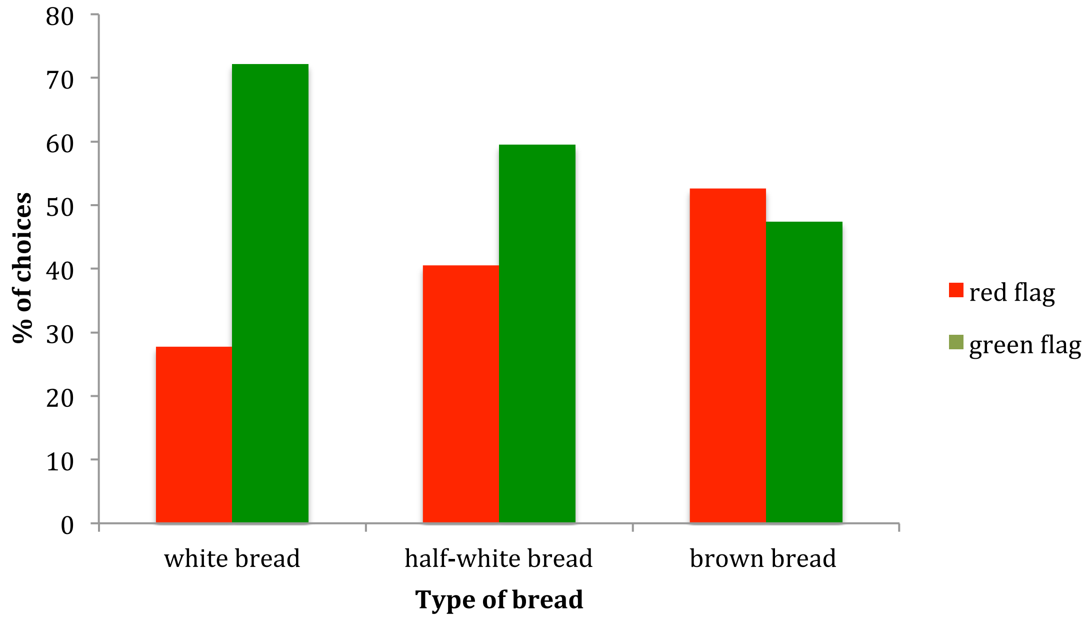


*Figure 2.* Percent of persons, whose favorite color was neither red nor green, who chose the option marked with a red flag or a green flag for white bread (unhealthy), mixed-flour bread (neither healthy nor unhealthy), and brown bread (healthy).