Short Research Article

Too Tasty to Be Ignored

How Individual Food Preferences Affect Selective Attention

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Abstract: Recent research has shown that even non-salient stimuli (colored circles) can gain attentional weight, when they have been loaded with some value through previous reward learning. The present study examined such *value-based attentional weighting* with intrinsically rewarding food stimuli. Different snacks were assumed to have different values for people due to individual food preferences. Participants indicated their preferences toward various snacks and then performed a flanker task with these snacks: they had to categorize a target snack as either sweet or salty; irrelevant flanker snacks were either compatible or incompatible with the target category. Results of a linear mixed-effects model show that the effect of flanker compatibility on participants' performance (response times) increased with the participants' preference toward the flanking snacks. This shows, for the first time, that attentional weightings in a flanker task with naturalistic stimuli (snacks) are modulated by participants' preferences toward the flankers.

Keywords: attentional capture, flanker task, food preferences, primary rewards, selective attention

In many situations our visual system is confronted with an abundance of stimuli of which in the end only few are selected for further processing. The mechanism by which some stimuli are selected at the expense of others is known as selective attention (Hübner, Steinhauser, & Lehle, 2010). Attentional selection of stimuli can be voluntary and driven, for example, by current goals of an individual (Folk, Remington, & Johnston, 1992), such as when a person in a supermarket attends to only those products on the shelf that are on her shopping list. However, attentional selection can also be involuntary and driven by salient stimuli (Theeuwes, 1992), such as when a product in a vividly colored packing on the supermarket shelf pops out from the surrounding products. Besides goal-driven and stimulus-driven effects on attentional selection, though, more recent research showed that the allocation of attention can also be influenced by the value, or the rewarding properties that participants associate with an otherwise non-salient and goal-irrelevant stimulus (Anderson, Laurent, & Yantis, 2011; Failing, Nissens, Pearson, Le Pelley, & Theeuwes, 2015).

A first demonstration of this value-based attentional selection was given by Anderson et al. (2011). Their participants engaged in a visual search task, requiring them to indicate the orientation of a bar embedded within either a red or a green target circle; the target was depicted among five differently-colored distractor circles. After each trial, participants received a large or a small monetary reward depending on the color of the target. Afterwards, participants performed a second visual search task, requiring them to search for a unique diamond shape among differently-colored circles. Although color was task-irrelevant in this task, participants' responses were impaired (slowed) when one of the distractors had a previously rewarded color, with the high-reward color producing stronger interference than the low-reward color.

Several studies have since replicated this effect of stimulus value on attentional selection (Anderson, Laurent, & Yantis, 2012; Wentura, Müller, & Rothermund, 2014). In all these studies, the stimuli gained their value through associative learning in an initial learning phase, and value has commonly been induced through monetary feedback. To our knowledge, however, there has been no study so far that investigated the effect of stimulus value on attention with stimuli for which participants already have some long-term value associations. Although it is intriguing to show that newly acquired value associations affect a person's subsequent deployment of attention, demonstrating a similar effect with stimuli that have long-term value associations may certainly support the effect's generalizability.

Typical examples of stimuli for which people commonly have long-term value associations are food items. That is, due to a person's individual food preferences, different food items may have become associated with different values for that person. Although food items and money are both rewarding, the behavioral consequences elicited by the two reward classes need not necessarily be the same, even when the rewards are merely hypothetical

(Holt, Newquist, Smits, & Tiry, 2014). As mentioned, the effect of stimulus value on attention has commonly been studied with monetary reward. Studying value-driven attentional effects with food items may therefore provide further evidence for the generalizability of the effect.[1] In sum, the goal of the present study was to investigate whether value-driven attentional selection, which has so far been studied with stimuli that became newly associated with monetary reward, can also be found with food items for which people have long-term value associations.

There is some evidence that palatable food items have an attentional advantage over nonfood items (e.g., office items; Nijs, Muris, Euser, & Franken, 2010). However, our question was not whether food items *in general* have an attentional priority over nonfood items. Rather, we were interested in whether food items can bias a person's attention to *varying degrees* depending on their individually associated value. That is, although palatable food items, like chocolate or crisps, are generally considered as intrinsically rewarding, the extent to which a food item is liked also depends on an individual's preferences (Stoeckel, Cox, Cook, & Weller, 2007). For example, one person may be keen on chocolate but relatively neutral toward crisps, whereas another person shows the reversed preference. The present study examines whether such individual preferences also control visual attention. Based on the findings from studies using secondary rewards (Anderson et al., 2011), we hypothesized that food items for which a person holds strong preferences would attract a person's attention more than food items which that person does not prefer that much.

Some evidence that food items attract attention to a varying degree comes from a recent study by Freijy, Mullan, and Sharpe (2014). These researchers used food items of high-caloric and low-caloric value (e.g., bacon and apple, respectively) and found that attentional bias toward high-caloric items was stronger than bias toward low-caloric items. Although this study shows that food items can affect attention differently, it differs from the present study in important respects. Specifically, Freijy et al. examined how specific *item-characteristics* – caloric value – affect attention. In our study, in contrast, we were interested in how *participants' individual preferences* toward various food items affect attention. Of course, it could have been that the high-caloric food items in Freijy et al. were also the more preferred items; but investigating the attentional effects of individual preferences was not the objective of that study. In the present study, in contrast, we use food items of predominantly high-caloric value (snacks), and we examine how participants' individual preferences for these items modulate attention. We did this by having participants perform a snack-categorization flanker task. Participants of this task had to categorize a target snack as either sweet or salty, and the target (e.g., sweet chocolate) was flanked by two identical snacks of either the same category as the target (*compatible*; e.g., sweet jelly babies) or the other category (*incompatible*; e.g., salty crisps). A common finding with the flanker task is that participants' responses are slower and less reliable when target and flankers are incompatible compared to when both are compatible – known as *flanker compatibility effect* (e.g., Eriksen & Eriksen, 1974). In the flanker task, the target typically receives a great attentional weight due to spatial attention; yet as indicated by the flanker compatibility effect, the flankers are nevertheless processed to some degree. If, as hypothesized, the value of the flankers modulates the flankers' attentional weight, then the compatibility effect should vary accordingly. That is, the more a person likes the flanking snacks the stronger these snacks should interfere with performance.

As stimuli, we used a set of images depicting various snacks from the sweet and salty category for which participants initially indicated their preferences. Each stimulus served as target as well as flanker across trials; thus both targets and flankers were assumed to vary in their values. Although our main hypothesis was about *flanker* preferences (i.e., increasing flanker effect with increasing flanker preferences), this design further allowed us to examine the effect of *target* preferences.

Using naturalistic stimuli is an ecologically valid approach, but it bears the risk of confounds. For example, some food items may be perceptually more salient than others, which, as mentioned, also influence visual attention. However, even if some items were more salient than others, their influence should be attenuated by the variability of participants' preferences for these items (i.e., not all participants may like the salient items most strongly; see Results section for more details). Moreover, to study the effect of individual snack preferences on attentional weighting, we used a linear mixed-effects model (LMM) approach (Baayen, Davidson, & Bates, 2008). A key advantage of LMMs is that they allow one to directly take stimulus-specific variance (e.g., due to saliency) into account by treating stimulus as a random factor. This way, any variability in the dependent variable produced by irrelevant stimulus features can be controlled for.

[1] Note that there has been some research investigating the effects of emotional valence on attention (e.g., the effects of positive or negative facial expressions; Horstmann, Borgstedt, & Heumann, 2006). Although food items may have some emotional valence, we do not refer to *emotional value* when we speak of stimulus value here. Rather, we use the term value specifically with regard to people's preferences, whereby food preferences were assumed to range from high to low value.

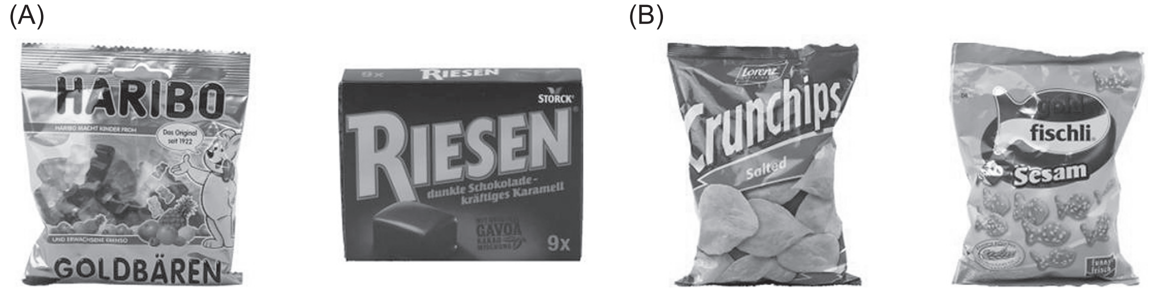

Figure 1. Example snacks from the flanker task. Images depict (A) two snacks from the sweet snack category and (B) two snacks from the salty snack category.

Method

Participants

Twenty-five students (M_{age} = 23.24 years; 21 female) from the University of Konstanz, Germany, participated for either partial course credit or 10€ per hour. The sample size was based on previous flanker studies from our laboratory which obtained reliable flanker effects and modulations of this effect with a similar sample size (Dambacher & Hübner, 2013).

Stimuli and Apparatus

Stimuli were 24 color images of palatable snacks; half of the images depicted a sweet snack the other half a salty snack. Figure 1 shows example images for both types of snacks. The stimuli were taken from a pool of 77 images, which were pretested for their likings by an independent sample of 52 participants. As in the original study, pretest liking ratings were given on a five-point rating scale (see Section Preference Ratings). The pretesting was done to create an item-set for which we could be sure that there would be at least some variability in liking ratings for our original study. To ensure liking variability, we selected six items from the 77 pretested stimuli for each category (sweet and salty) for which the average rating was above the scale midpoint and six for which the average rating was below (or equal to) the midpoint.

For the flanker task, target-flanker pairs were constructed by pairing each stimulus, designated as target, with each of the remaining 23 stimuli, designated as flanker, which resulted in 552 (24 × 23) target-flanker pairs. To have an equal number of compatible and incompatible pairs, we further included those 24 pairs for which target and flanker were identical (compatible) resulting in a total of 576 pairs.

Stimuli were presented on an 18″ color monitor with a resolution of 1280 × 1024 pixel and a refresh rate of 60 Hz. All stimulus images measured 8.15° visual angle (width and height). The stimulus designated as target was presented at the center of the screen. The stimulus designated as flanker was shown at either side of the target with a distance of 2.45° visual angle. Participants' viewing distance was approximately 50 cm. Responses were given by pressing one of two mouse-buttons (left or right). The experiment was programmed in Python (version 2.7).

Procedure

Preference Ratings

Participants were shown each of the 24 snack images once, and they were asked to indicate how much they liked each snack. Ratings were made on a five-point rating scale (0 = *don't like it all*; 4 = *like it extremely*). There was no time constraint for responses. Stimulus sequence was randomly determined for each participant.

Flanker Task

Each trial started with a fixation cross depicted at the center of the screen for 300 ms, followed by a blank screen of 400 ms duration. Then target and flankers appeared for 400 ms, followed again by a blank screen, which remained until participants made a response; it was also possible for participants to respond already during stimulus presentation in which case the screen would have turned blank immediately. In either case, once a response was made, the screen remained blank for another 1,000 ms until the next trial started. Participants' task was to indicate whether the target stimulus was a sweet snack ("Süßigkeit" in German) or a salty snack ("Knabberei" in German) by pressing the corresponding mouse-button; assignment of snack categories to mouse-buttons was counterbalanced. Participants were told to ignore the flankers in this task. Incorrect responses were signaled by an 800 Hz sound of 100 ms duration.

There were eight experimental blocks of 72 trials (= 576 trials); the 576 target-flanker pairs were randomly assigned to the trials. Participants were free to take a short break between the experimental blocks. To familiarize participants with the task, we had them perform 15 training trials prior to the first block; training stimuli were randomly chosen from the stimulus set.

Results

Preference Ratings

The average preference ratings for the 24 snacks are given in Table 1 in Electronic Supplemental Material 1. Ratings ranged from 1.00 to 2.96, indicating that some items were preferred more than others. Moreover, a one-way repeated-measures analysis of variance (ANOVA) with preference rating as dependent variable and snack category (sweet vs. salty) as independent variable revealed a significant difference, $F(1, 24) = 6.58$, $p = .017$. Overall, participants preferred salty snacks ($M = 2.41$, $SD = 1.17$) over sweet snacks ($M = 1.99$, $SD = 1.33$). To rule out that participants' *general* preferences for one category (e.g., salty) over the other category (sweet) may confound the effect of *individual* snack preferences, we *z*-standardized the individual preference ratings for each participant within the corresponding category of the items; that is, for each participant the mean preferences and standard deviations for sweet and salty items were calculated and each item was then standardized on the basis of the corresponding category mean and standard deviation. This way, we removed any general preferences for the categories and could directly assess the effect of individual snack preferences.

In addition, as we were particularly interested in the effect of individual snack preferences it was necessary to ascertain that participants did not tend to prefer the same snacks. If they had preferred the same snacks, then item-specific effects may have confounded individual preferences effects. Therefore, to assess the degree of consistency among participants' snack ratings we calculated Cronbach's alpha. The resulting relatively low value of $\alpha = 0.34$ suggests that there was only a modest degree of consistency among participants' preferences (i.e., participants seemed to differ in their preferences). However, to further corroborate our argument and to demonstrate the specific role of individual snack preferences, we ran the main analysis below once with the individual preference ratings and once with the mean preference ratings for each snack averaged across participants. If, contrary to our assumption, participants show similar preferences for the snacks, then the group ratings should yield similar effects as the individual preferences.

Response Times

Response times (RTs) of correct responses (91.53%) were analyzed with a linear mixed-effects model using the R-package lme4 (Bates, Maechler, Bolker, & Walker, 2015). Outliers, defined as RTs smaller than 100 ms or RTs greater than individual mean plus 2.5 standard deviations (1.99%), were removed prior to analysis. For the modeling, both participant and stimulus were treated as *random effects* (i.e., intercepts were allowed to vary by participant and by stimulus). The *fixed effects* of our model (the predictor variables) were (a) flanker-target compatibility, (b) flanker preference, and (c) target preference, as well as their interactions. Target-flanker compatibility was dummy-coded (0 = *incompatible*; 1 = *compatible*). We ran two models: In the first model, we used the individual preference ratings for each snack; in the second model, we used the average preference ratings for each snack.

The coefficients estimated for the first model are shown in Table 1. Confidence intervals for the coefficients were obtained via the R-function *confint* using the method *boot* (bootstrapping). Reported *p*-values and degrees of freedom are based on the Satterthwaite approximation. As can be seen in Table 1, target-flanker compatibility had a significant effect on RTs; as indicated by the negative sign of the coefficient, responses became faster when target and flanker were compatible (typical flanker effect). As further shown in Table 1, the effect of flanker preference approached significance. But most importantly, flanker preference significantly interacted with target-flanker compatibility, indicating that the flanker effect was modulated by flanker preference. The interaction is depicted in Figure 2. Consistent with our hypothesis, the figure shows that the flanker effect (i.e., the effect of target-flanker compatibility) increased as individual preferences for the flankers increased. No other effects were significant.

The second model – with group preference ratings as predictors – only revealed a significant effect of target-flanker compatibility, $b = -8.41$ ($SE = 1.55$), $t(12{,}860) = -5.44$, $p < .001$. No other effects were significant (p's $> .338$). Thus, the above analyses suggest that the modulation of the flanker effect is specific to individual preferences and does not occur with group preferences. This also rules out the possibility that item-specific effects were responsible for the modulation of the flanker effect.

Accuracy

We also examined response accuracy for the flanker task to check whether the RT results reflect a general speed-accuracy tradeoff. Responses were coded as either correct (= 1) or incorrect (= 0) and were analyzed with a

Table 1. Coefficients estimated by a linear mixed-effects model with participant and stimulus as random effects and response times from the flanker task as predicted variable

Predictor	Coefficient (*SE*)	95% CI	*df*	*t*-value	*p*
Target-flanker compatibility (Compatibility)	−8.55 (1.52)	[−11.5, −5.6]	12,865	−5.61	< .001
Target preference	−0.49 (1.18)	[−1.8, 2.8]	12,517	0.41	.681
Flanker preference	2.17 (1.13)	[−0.04, 4.4]	12,865	1.92	.054
Compatibility × Target Preference	−2.60 (1.59)	[−5.7, 0.5]	12,865	−1.64	.101
Compatibility × Flanker Preference	−4.30 (1.59)	[−7.4, −1.2]	12,865	−2.71	.007
Target Preference × Flanker Preference	0.29 (1.18)	[−2.0, 2.6]	12,865	0.24	.808
Compatibility × Target × Flanker Preference	0.69 (1.65)	[−2.5, 3.9]	12,865	0.42	.676

Note. SE = standard error; CI = confidence interval; *df* = degrees of freedom.

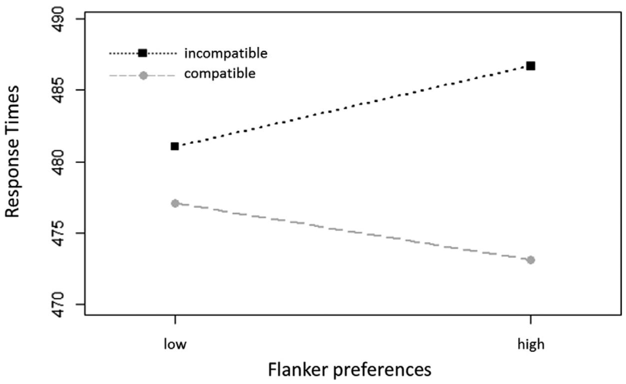

Figure 2. Predicted response times from the flanker task as a function of target-flanker compatibility and flanker preference. The plot depicts predicted values at −1 *SD* (low) and +1 *SD* (high) on the flanker preference variable.

generalized linear mixed-effects model – an extension of a linear mixed-effects model that can be applied to a *dichotomous* dependent variable (thus being similar to logistic regression but extended to nested data). As in the LMM of the RT data, we included participant and stimulus as random effects in the model. The predictor variables (fixed effects) were again target-flanker compatibility, flanker preference, target preference, and their interaction terms. As in logistic regression, significance of the coefficients was tested with the Wald *z*-test.

In brief, the analysis revealed a significant effect of target-flanker compatibility on response accuracy, b = 0.19 (SE = 0.06), z = 3.10, p = .002, and a marginally significant interaction between target and flanker preference, b = −0.08 (SE = 0.05), z = −1.85, p = .065. No other effects were significant (p's > .235). The positive sign of the coefficient for compatibility indicates that responses were more accurate when target and flanker were compatible compared to when both were incompatible. This finding, together with the lack of an interaction between compatibility and flanker preference, speaks against the assumption of a general speed-accuracy tradeoff.

Ancillary Post Hoc Analyses

The presently found modulation of the flanker effect by flanker preferences was in line with our hypothesis that flankers would attract more attention the more they are liked. An alternative explanation could be, however, that the category-responses of the more preferred flankers were more easily available than the category-responses of the less preferred flankers. As a result, more preferred flankers might have interfered more strongly with participants' responses because their category-response was more easily available and not so much because they attracted more attention. Thus, response availability of the flankers may have confounded the effect of flanker preferences.

To check for this possibility we operationalized a snack's category-response availability in the following way. In our flanker task, there was one trial for each of the 24 snacks, where target and flanker were identical – that is, on these trials three images of the *same* snack were presented. We took the speed with which a participant categorized a snack on such a trial as a measure of that snack's response availability. We then first examined whether snack preference was related to the snack-categorization speed. To this end, we regressed the response times for the 24 snacks on the preference ratings of these snacks in a linear mixed-effects model with participant and snack as random factors. The coefficient for preference ratings was significant, b = −6.12 (SE = 2.99), t(487.5) = −2.04, p = .042. This indicates that snack-categorization speed (category-response availability) increased with snack preference. We next examined whether response availability of the snacks confounded the effect of individual snack preferences. We did this by running the same analysis as reported above (with individual snack preferences as predictors) but further included response availability of the target, response availability of the flanker, and their interactions with target-flanker compatibility as predictors in the model. In this model, target-flanker compatibility was again significant, b = −9.16 (SE = 1.57), t(12,320) = −5.84, p < .001, as was the interaction between compatibility and response availability of the target, $b = -0.037$ ($SE = 0.016$), $t(12{,}320) = 2.29$, $p = .022$. The latter finding suggests that the influence of target-flanker compatibility on RTs became weaker, the more available the response for the target was. Most importantly, however, the interaction between compatibility and individual flanker preference was still significant, $b = -4.01$ ($SE = 1.63$), $t(12{,}320) = -2.46$, $p = .014$. Thus, even after controlling for the availability of categorization responses, flanker preference still modulated the flanker effect, suggesting that category-response availability of the flankers could not explain the effect of participants' preferences for the flankers.

Discussion

Palatable food is intrinsically rewarding and previous research has already shown that food items have an attentional priority over nonfood items (Nijs et al., 2010). The present study went a step further by showing that food items can modulate attentional weights, depending on a person's preferences: Participants' performance in a snack-categorization flanker task was affected by task-irrelevant snacks the stronger the more participants liked the snacks. To our knowledge, this is the first study showing that food items differ in the extent to which they bias a person's attention depending on the person's preferences toward these items.

A recent study by Freijy et al. (2014) demonstrated that people show a generally strong attentional bias toward high-caloric compared to low-caloric food. Yet, as presented in our study, even for high-caloric food items (palatable snacks), there is some room for attentional modulation. Attention was significantly influenced by people's preferences for the different snacks. This result demonstrates that the potential of food items for biasing attention not only depends on item-specific characteristics (e.g., caloric value), but also on person-specific preferences. This assumption was further corroborated by our additional analyses. Specifically, it could have been argued that our participants tended to prefer the same snacks (e.g., high-caloric snacks) so that individual preferences were confounded with item-specific characteristics. Our analysis, however, revealed only a modest degree of consistency among participants' preference ratings. Furthermore, an analysis with the average group ratings for each snack yielded no significant modulation of the flanker effect. Together, these findings support our assumption that attention was modulated by individual preferences and not by low-level stimulus properties.

Our result that food items attract more visual attention the more they were liked, is in line with the idea of value-based attentional weighting (Anderson et al., 2012). In previous studies within this domain, the value of otherwise neutral stimuli was manipulated by associating these stimuli with money through learning (Anderson et al., 2011, 2012; Wentura et al., 2014). Our findings generalize the previously found effect of stimulus value on visual attention to food stimuli – stimuli for which people already have some long-term value associations. The use of naturalistic food stimuli has high ecological validity, but it may come with the cost of confounds. Some of the possible confounds, related to stimulus-specific characteristics, have already been discussed. However, in addition to stimulus-specific confounds, another serious variable that could have confounded the effect of flanker preference in our study is stimulus familiarity. Specifically, participants may have been more familiar with those snacks they liked more. For the more familiar snacks, in turn, the snack category, and thus the categorization response, may have been more easily available. According to this account, then, the modulation of the flanker effect may have been due to the availability of the category response of the flankers rather than to the attraction of attention to the flankers. Put differently, one could argue that more preferred flankers may have interfered more strongly with participants' responses because they elicited *quicker* task-irrelevant categorization responses and not because they attracted more attention (which in turn may have produced *stronger* response activations).

Although in the present study we had no direct measure of snack familiarity, it was possible for us to examine whether category-response availability of the flankers confounded the effect of flanker preferences. Our additional (post hoc) analysis showed that flanker preferences modulated the flanker effect even when category-response availability was controlled for. Thus, the speed with which flankers may have elicited a task-irrelevant response could not explain why more preferred flankers interfered more strongly with participants' responses. We suggest therefore that attentional mechanisms may have played an important role in modulating the flanker effect, such that more preferred flankers attracted more attention and this in turn may have resulted in stronger response activations of the flankers.

Notwithstanding the previous argument, however, theoretical reasoning and empirical research suggests that several stages of stimulus processing (visual attention and response selection) are involved in producing the flanker effect (e.g., Hübner et al., 2010; Mattler, 2006). It might therefore be interesting for future research to examine how, or at what stage, individual snack preferences affect attention. For instance, do more preferred snacks initially attract more attention (attentional capture) and therefore interfere more strongly with responses? or do people have more difficulty to disengage their attention from those snacks they like most, which also would lead to stronger interference? One possibility to investigate these questions may be to examine the effects of snack preferences on attention with different paradigms, such as a visual search task (e.g., as in Anderson et al., 2011) or modifications of a spatial cueing paradigm (see Clarke, MacLeod, & Guastella, 2013, for a critical overview and discussion of these paradigms, especially with regard to the attentional processes they are supposed to measure). Using such paradigms might help to shed light on the specific attentional processes (e.g., capture or disengagement) underlying the effects of snack preferences on visual attention.

The study of the interplay between attention and preferences has received a lot of interest in recent research. Whereas our findings show that preferences affect visual attention in a conflict task, another line of research provides supporting evidence that attentional control and conflict also have affective consequences (Dreisbach & Fischer, 2012; Martiny-Huenger, Gollwitzer, & Oettingen, 2014). For example, using a flanker paradigm with relatively neutral Chinese characters, Martiny-Huenger et al. (2014) showed that those Chinese characters of the task that were consistently shown as flankers evoking a conflicting response were subsequently devalued. It might be interesting to see whether a devaluation of flanker stimuli would also be obtained when stimuli are used for which participants already have some preferences, such as the snacks in our study.

Taken together, the present study adds to a growing line of research investigating the interplay between attention and preference. Within the domain of value-driven attentional selection, the present findings provide supporting evidence for the generalizability of the effect of stimulus value on attention, which has so far been demonstrated with neutral stimuli that became newly associated with money.

Acknowledgments

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Electronic Supplemental Materials

The electronic supplementary material is available with the online version of the article at https://doi.org/10.1027/1618-3169/a000373

ESM 1. Table (pdf).
The table shows mean preference ratings for the 24 snack stimuli averaged across participants.
ESM 2. Raw data RTs (csv).
File contains the raw data for each participant.
ESM 3. Raw data ratings (csv).
File contains the rating data for each participant.
ESM 4. R script (R).
File contains the R script with the analyses.

References

Anderson, B. A., Laurent, P. A., & Yantis, S. (2011). Value-driven attentional capture. *Proceedings of the National Academy of Science USA, 108*, 10367–10371. https://doi.org/10.1073/pnas.1104047108

Anderson, B. A., Laurent, P. A., & Yantis, S. (2012). Generalization of value-based attentional priority. *Visual Cognition, 20*, 647–658. https://doi.org/10.1080/13506285.2012.679711

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language, 59*, 390–412. https://doi.org/10.1016/j.jml.2007.12.005

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software, 67*, 1–48. https://doi.org/10.18637/jss.v067.i01

Clarke, P. J. F., MacLeod, C., & Guastella, A. J. (2013). Assessing the role of spatial engagement and disengagement of attention in anxiety-linked attentional bias: A critique of current paradigms and suggestions for future research directions. *Anxiety, Stress, & Coping, 26*, 1–19. https://doi.org/10.1080/10615806.2011.638054

Dambacher, M., & Hübner, R. (2013). Investigating the speed-accuracy trade-off: Better use deadlines or response signals? *Behavior Research Methods, 45*, 702–717. https://doi.org/10.3758/s13428-012-0303-0

Dreisbach, G., & Fischer, R. (2012). Conflicts as aversive signals. *Brain and Cognition, 78*, 94–98. https://doi.org/10.1016/j.bandc.2011.12.003

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception & Psychophysics, 16*, 143–149. https://doi.org/10.3758/BF03203267

Failing, M., Nissens, T., Pearson, D., Le Pelley, M., & Theeuwes, J. (2015). Oculomotor capture by stimuli that signal the availability of reward. *Journal of Neurophysiology, 114*, 2316–2327. https://doi.org/10.1152/jn.00441.2015

Folk, C. L., Remington, R. W., & Johnston, J. C. (1992). Involuntary covert orienting is contingent on attentional control settings. *Journal of Experimental Psychology: Human Perception and Performance, 18*, 1030. https://doi.org/10.1037/0096-1523.18.4.1030

Freijy, T., Mullan, B., & Sharpe, L. (2014). Food-related attentional bias. Word versus pictorial stimuli and the importance of stimuli calorific value in the dot probe task. *Appetite, 83*, 202–208. https://doi.org/10.1016/j.appet.2014.08.037

Holt, D. D., Newquist, M. H., Smits, R. R., & Tiry, A. M. (2014). Discounting of food, sex, and money. *Psychonomic Bulletin & Review, 21*, 794–802. https://doi.org/10.3758/s13423-013-0557-2

Horstmann, G., Borgsted, K., & Heumann, M. (2006). Flanker effects with faces may depend on perceptual as well as emotional differences. *Emotion, 6*, 28–39. https://doi.org/10.1037/1528-3542.6.1.28

Hübner, R., Steinhauser, M., & Lehle, C. (2010). A dual-stage two-phase model of selective attention. *Psychological Review, 117*, 759. https://doi.org/10.1037/a0019471

Martiny-Huenger, T., Gollwitzer, P. M., & Oettingen, G. (2014). Distractor devaluation in a flanker task: Object-specific effects without distractor recognition memory. *Journal of Experimental Psychology: Human Perception and Performance, 40*, 613.

Mattler, U. (2006). Distance and ratio effects in the flanker task are due to different mechanisms. *The Quarterly Journal of Experimental Psychology, 59*, 1745–1763. https://doi.org/10.1080/17470210500344494

Nijs, I. M. T., Muris, P., Euser, A. S., & Franken, I. H. A. (2010). Differences in attention to food and food intake between overweight/obese and normal-weight females under conditions of hunger and satiety. *Appetite, 54*, 243–254. https://doi.org/10.1016/j.appet.2009.11.004

Stoeckel, L. E., Cox, J. E., Cook, E. W. 3rd, & Weller, R. E. (2007). Motivational state modulates the hedonic value of food images differently in men and women. *Appetite, 48*, 139–144. https://doi.org/10.1016/j.appet.2006.07.079

Theeuwes, J. (1992). Perceptual selectivity for color and form. *Perception & Psychophysics, 51*, 599–606. https://doi.org/10.3758/BF03211656

Wentura, D., Müller, P., & Rothermund, K. (2014). Attentional capture by evaluative stimuli: Gain-and loss-connoting colors boost the additional-singleton effect. *Psychonomic Bulletin & Review, 21*, 701–707. https://doi.org/10.3758/s13423-013-0531-z

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