Journal of Experimental Social Psychology 86 (2020) 103892

Contents lists available at ScienceDirect

Journal of Experimental Social Psychology

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

Case Report

Attitudes and attention

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ARTICLE INFO

Keywords:
Attitude accessibility
Drift diffusion model
Decision-making
Eye-tracking
Attitude certainty
Attitude stability

ABSTRACT

Attitudes play a vital role in our everyday decisions. However, it is unclear how various dimensions of attitudes affect the choice process, for instance the way that people allocate attention between alternatives. In this study we investigated these questions using eye-tracking and a two alternative forced food-choice task after measuring subjective values (attitude extremity) and their accompanying accessibility, certainty, and stability. Understanding this basic decision-making process is key if we are to gain insight on how to combat societal problems like obesity and other issues related to diet. We found that participants allocated more attention to items with lower attitude accessibility, but tended to choose items with higher attitude accessibility. Higher attitude certainty and stability had no effects on attention, but led to more attitude-consistent choices. These results imply that people are not simply choosing in line with their subjective values but are affected by other aspects of their attitudes. In addition, our attitude accessibility results indicate that more attention is not always beneficial.

1. Introduction

Decisions permeate our everyday lives. They range from the mundane, such as whether to take the freeway or surface streets to work, to the more impactful, such as what career path to take. Decisions are influenced by features of the social environment such as advertisements, peer influence, and other social pressures. To gain insight into how these features of the environment impact peoples' choices, and to combat societal problems like obesity and addiction, we must better understand basic decision-making processes (Mann, de Ridder, & Fujita, 2013). One important way in which social factors might influence decisions is via attention. In recent years, research has shown a clear link between visual attention and choice outcomes (Krajbich, 2019). In particular, it has been shown that gaze has an amplifying effect on subjective values, increasing the perceived attractiveness of positively valenced alternatives (Smith & Krajbich, 2019).

What remains unclear from this research are the factors that may attract (or repel) attention. We know that the visual features of items, such as brightness and uniqueness, can attract attention (Theeuwes, 1991) and thus affect choice (Mormann, Navalpakkam, Koch, & Rangel, 2012; Towal, Mormann, & Koch, 2013). However, other less objective features of items may also be able to influence attention. Subjective value is just one aspect of one's attitude towards an alternative. Here, we are interested in how other aspects of attitudes (Fazio, Blascovich, & Driscoll, 1992), can influence the choice process. Past work has investigated the effects of subjective values (i.e. attitude extremity), as measured by liking ratings, on attention, and found little to no effect (Krajbich, Armel, & Rangel, 2010; Smith & Krajbich, 2018). However, little is known about the effects of the ease with which one is able to recall their attitude towards an item, how consistent that attitude is, or how certain one is about that attitude.

For instance, it may take time to recall how much you enjoy a candy bar that you haven't tasted in years, which would make your attitude for that item difficult to access. Consequently, that item might attract more attention, while you attempt to retrieve your attitude. On the other hand, items whose attitudes are easier to access may naturally attract attention (Fazio et al., 1992; Roskos-Ewoldsen & Fazio, 1992). Relatedly, the literature on fluency, i.e. the ease of processing information, has also shown that fluent information can attract more attention (Oppenheimer, 2008).

Similarly, you may know that you enjoy chocolate, but be unsure about how much you would like to eat this particular candy bar right now, resulting in low certainty or stability. As a result, you may spend more time evaluating that option to try to reduce your uncertainty (Cassey, Evens, Bogacz, Marshall, & Ludwig, 2013; Lejarraga, Hertwig, & Gonzalez, 2012; Pachur & Scheibehenne, 2012). Another possibility

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https://doi.org/10.1016/j.jesp.2019.103892
Received 30 January 2019; Received in revised form 31 August 2019; Accepted 1 September 2019
Available online 13 September 2019

is that high-confidence or high stability items may draw more attention during the choice process, as that may facilitate a more coherent and quick decision (Festinger, 1957; Jekel, Glöckner, & Bröder, 2018).

In this study we sought to establish the effects of attitude accessibility, stability, and certainty, on participants' patterns of visual attention and their choices. We utilized eye-tracking technology to measure participants' eye movements while they made a series of choices between snack foods.

1.1. Attention in choice

Attention has been known to be involved in the choice process for decades. Going back to the mid 70s, eye-tracking and verbal recounting of one's search pattern, or fixation pattern, were already being used to study how attention and choices were intertwined (Payne, Braunstein, & Carroll, 1978; Russo & Rosen, 1975). More recently, studies have begun to develop attention-guided sequential sampling models, such as the attentional drift diffusion model (aDDM) which assume that attitude information is sampled, accumulated, and compared during the choice process, in a way that favors the currently attended alternative (Krajbich, 2019). These models account for several robust empirical findings, including correlations between relative dwell time and choice, and between the final fixation location and choice.

Additional studies have attempted to directly manipulate attention to study its role in decision making (Armel, Beaumel, & Rangel, 2008; Colas & Lu, 2017; Gwinn, Leber, & Krajbich, 2019; Lim, O'Doherty, & Rangel, 2011; Mormann et al., 2012; Parkhurst, Law, & Niebur, 2002; Pärnamets et al., 2015; Shimojo, Simion, Shimojo, & Scheier, 2003; Towal et al., 2013). These studies have repeatedly found that biasing attention biases choices, though sometimes these effects are small and/or not significant (Ghaffari & Fiedler, 2018; Newell & Le Pelley, 2018).

Thus one can say with a fair degree of confidence that attention is not only a factor in choice, but is a *causal* factor in choice. This means that anything that interacts with or draws attention, such as salience, can have some effect on the choices we make. Included in these possible factors are the various aspects of attitudes.

There is a small body of literature that indicates that greater attitude accessibility, and possibly by extension other facets of attitude strength, lead to more attention (Roskos-Ewoldsen & Fazio, 1992; Smith, Fazio, & Cejka, 1996). However, these studies have used response-time (RT) latency as the measure of attention, and these results have not yet been replicated with eye tracking.

2. Methods

2.1. Participants

This study is based on the data of 36 participants. Initially, we recruited 49 Ohio State University (OSU) students through the economics department research pool. The sample size was chosen to match our lab's prior studies using similar food-choice with eye-tracking paradigms. With these 36 participants, we had 80% power to detect an effect size of d = 0.48 for the paired *t*-test on the effect of accessibility on relative dwell time. However, our other analyses rely on mixed-effects regressions that leverage the fact that we have 200 trials per participant. For the analyses of relative dwell time on accessibility, certainty, stability, and extremity difference we determined that we had 80% power to detect effects of $\beta = 0.033$, $\beta = 0.0049$, $\beta = 0.024$, and $\beta = 0.025$ respectively (using the R function lmmpower).

In this study we report all measures, manipulations, and exclusions. Three participants were excluded for technological reasons (computer crashes, corrupted datafile, inability to calibrate). Another ten participants did not complete the study because they rejected too many foods to create a sufficient number of choice trials. Participants were paid $15 for their participation and also could receive one food item. To increase motivation during the study, we asked participants not to eat for 3 h prior to the study. The Ohio State University Internal Review Board approved the study and participants provided informed consent prior to participation.

2.2. Materials

Stimuli were presented on a BenQ monitor using Matlab (Mathworks) and Psychtoolbox (Brainard, 1997; Kleiner et al., 2007; Pelli, 1997). During the entirety of the study, participants' eyes were tracked using an SR Research Eyelink 1000 Plus eye tracker. Calibration on the eye tracker took place at the beginning of the study, and every trial was preceded by a mandatory fixation period during which participants had to fixate a dot at the center of the screen for 500 ms before the trial would begin. We used the default criterion for accepted calibration, as well as for validation accuracy.

Participants used the keyboard to make their yes/no and two alternative forced choices, and used a trackball mouse to provide liking and confidence ratings.

2.3. Procedure

2.3.1. Measuring accessibility

The first task that participants completed was designed to measure attitude accessibility. Each participant was presented with a sequence of 147 snack foods. For each of these foods, participants saw an image of the food at the center of the screen along with the words “YES” and “NO” below the image. Participants were instructed to respond yes or no to the question “If I were to offer you this food right now, would you eat it?” by pressing the left or right arrow key (these locations were counterbalanced across participants). At that point, the chosen word would change color from white to yellow to indicate the participant's choice (Fig. 1A).

Participants were informed at the beginning of the task that one of these trials might be selected for compensation at the end of the experiment. If one of these trials was realized, and the participant's choice on that trial was “NO,” the participant would not receive any food for their participation in the study, whereas if their answer was “YES” they would receive that food.

This task served two purposes. First, we used the participant's response time (RT) in each trial as our measure of the accessibility of their attitude towards that food item. The shorter the RT, the more accessible the attitude. Second, for the remainder of the study we only included items to which the participants responded “YES”. The effects of attention on choice in the aversive domain are less well studied and practically more difficult to incentivize. In keeping with prior studies in this literature we thus restricted ourselves to positively rated items (Krajbich et al., 2010).

2.3.2. Measuring attitude extremity and certainty

The second task that participants completed involved liking and confidence ratings for each of the foods that they said yes to in the first task (mean = 94 items, min = 36, max = 146, median = 95, total across participants = 3406). Participants rated each food on a scale from 1 to 10 where a rating of 1 indicated that they “would not like to eat this food very much right now” and 10 indicated that they “would love to eat this food right now.” Each item was presented in the center of the screen and was encircled by integer ratings from 1 to 10. These ratings appeared equidistant from their neighbors as well as from the food. Each number appeared in a grey circle in order to make it clear that one could not choose non-integer ratings (e.g. 4.3). In order to indicate their preferred rating, participants used a track ball to move the cursor over to the rating they wanted. Once the cursor entered one of the circles, that circle changed color to yellow in order indicate the participant's choice (Fig. 1B).

Immediately following each rating, participants were asked to indicate how confident they were in that rating. Possible confidence

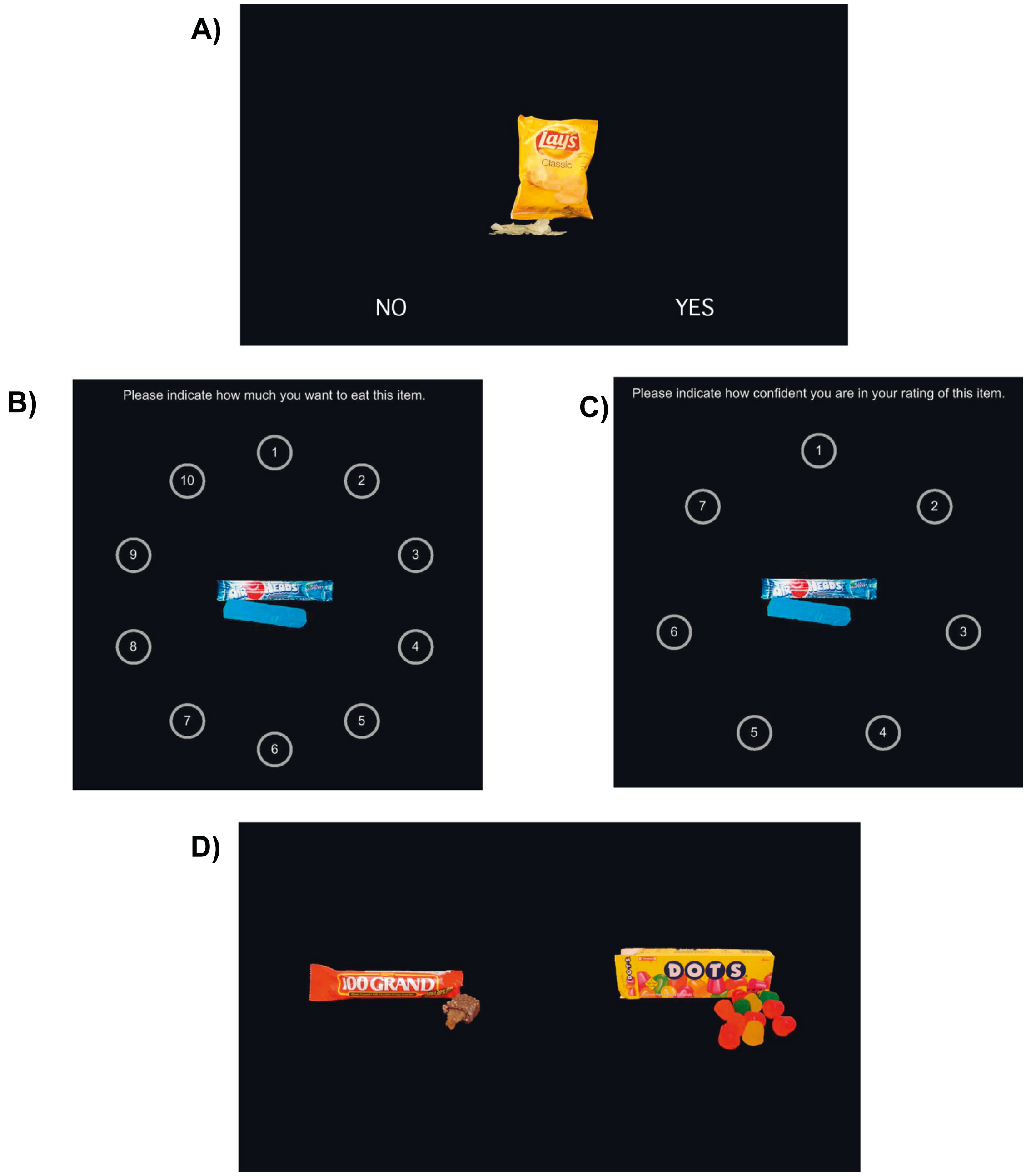

Fig. 1. Task timeline. Participants completed 5 separate tasks. (A) First, they were asked whether or not they would eat each food item. The RTs from this task were used to measure attitude accessibility with lower RTs signaling higher accessibility. (B) They next completed a rating task, rating from 1 to 10 how much they would like to eat the displayed food item (1 being "not at all" and 10 being "would love to"). (C) Immediately following the rating for each item, subjects indicated how confident they were in the rating they just gave on a scale from 1 to 7 (1 being "not at all" and 7 being "extremely"). (D) Subjects then chose which of two displayed food items they would like to eat. Finally, subjects completed the same rating task (A), without confidence ratings, at the end of the study.

ratings were integers from 1 to 7, where a confidence rating of 1 indicated that the participant was not at all sure that their rating reflected their true liking of the item, while a rating of 7 indicated that they were very sure that their rating reflected how much they liked the item. As with the liking ratings, the confidence ratings were equidistant from the center food item as well as from their neighbors and appeared within grey circles. Participants indicated their confidence rating by rolling the cursor over the desired rating using the track ball. Once the cursor entered one of the circles, that circle changed color to yellow in order indicate the participant's choice (Fig. 1C).

These liking rating served as our measure of attitude extremity and were used to select pairs of similarly liked foods for the subsequent two-alternative forced choice task. The confidence ratings served as our measure of attitude certainty.

2.3.3. *Two-alternative forced choice*

Following the rating and confidence task, participants completed 200 trials of a two-alternative forced choice task. Participants were asked to decide which food they would prefer to eat at the end of the study. These choices were incentivized: at the end of the study one trial from this task might be selected, in which case the participants would receive the food they chose in that trial.

In all choice trials the maximum difference in liking rating between two foods was 1 so as to try to limit difference in attitude extremity between the two items. Participants used the left and right arrow keys to choose the corresponding food. Once a choice was made, a blue box appeared around the chosen item (Fig. 1D).

During these choices we recorded participants' eye movements.

2.3.4. Re-rating/strength

The final task that participants completed was to re-rate each food one at a time, but this time without also giving a confidence rating. Aside from that, and the order of the items, this was identical to the earlier liking rating task. The absolute difference between these re-ratings and the original ratings served as our measure of attitude stability.

3. Results

3.1. Replication of previous findings

Before considering the effects of attitude accessibility, certainty, and stability, we first sought to replicate the basic relationships between the liking ratings, eye movements, and choice. We used a logistic mixed-effects regression to predict which food a participant would choose in a given trial, based on the rating difference and the total dwell-time difference between the two items. The dwell time captures the total amount of time that a participant was fixated on a given item over the course of the trial. In line with past research, we found that both rating difference ($\beta = 0.67$, $p < .001$) and dwell-time difference ($\beta = 0.66$, $p < .001$) were significant predictors of choice (Fig. 2A).

A second robust finding from past research is a correlation between the last item that a participant looks at and their choice. This relationship is not constant; it depends on the attitudes towards the two items. When two options are roughly equally attractive, the last fixation location is highly predictive of the choice. When the two options are very different in rating, participants will tend to choose the higher-rated item regardless of where they look last. This was indeed the case in our data as well (Fig. 2B). Here we used another logistic mixed-effects regression to predict choice (left vs. right) based on the last fixation location (left vs. right), and rating difference (left–right). As expected, last fixation location was a significant predictor of choice ($\beta = 0.86$, $p < .001$).

Basic properties of the eye-tracking data such as number of dwells per trial and mean dwell times can be found in the Supplementary material (Figs. S1–3).

3.2. Attitude measures

3.2.1. Defining accessibility

A typical way to measure attitude accessibility is to measure the time that it takes for a participant to indicate their attitude towards that

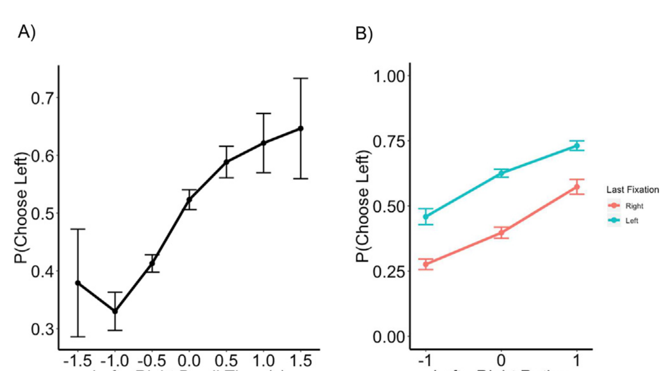

Fig. 2. Gaze effect on choice. A) The probability of choosing the left item depends on the difference in time spent looking at the left item compared to the right item. B) The probability of choosing the left item depends on the difference in rating between the items, but also on which item was looked at last. Errors bars are s.e.m.

item (Roskos-Ewoldsen & Fazio, 1992). However, we were concerned that a participant's RT to the YES/NO question in our study might also be a function of attitude extremity, i.e. the rating assigned to the item. That is, if a participant responded "YES" to an item that was subsequently rated a 10, the YES/NO choice should have been very easy and thus quite fast, relative to an item subsequently rated a 1, for example.

To determine if this was actually the case, we ran a mixed-effects linear regression of log(RT) from the YES/NO choice on that item's liking rating from the first rating task. We found a significantly negative coefficient on rating ($\beta = -0.05$, $p < .001$), confirming the hypothesized effect (see also Fig. S4). In order to have a cleaner measure of accessibility, uncontaminated by these effects of attitude extremity, we ran these same regressions at the participant level and used the residual RTs as our measures of attitude accessibility. For clarity in our analyses, we multiplied accessibility by -1 so that higher scores indicate higher accessibility and lower scores indicate lower accessibility.

3.2.2. Defining certainty

For attitude certainty we simply used the confidence ratings given by each participant for each food.

3.2.3. Defining stability

For attitude stability we calculated the absolute difference between the first and second rating given by each participant for each food. Re-rating difference poses a unique challenge because variability mechanically goes down as one approaches the upper and lower bounds on the rating scale (see Fig. S5). Also, past work has shown that preferences can change over time as a result of the choice process. In particular, items that are chosen more over the course of the study are expected to show upward shifts in their ratings at the end (Izuma & Murayama, 2013; Strandberg, Sivén, Hall, Johansson, & Pärnamets, 2018). In order to correct for these artifacts, we ran quadratic regressions for each subject as follows (see Supplementary material):

$$| 2^{nd} rating - 1^{st}\ rating | \sim \beta_0 + \beta_1 * 1^{st}\ rating + \beta_2 * 1^{st}\ rating^2 + \beta_3 * \#choices + \beta_4 * \#choices^2$$

We used the residuals of these regressions as our measures of attitude stability. As with accessibility, because less of a difference between the first and second rating corresponds to greater attitude stability, we multiplied the resulting measure of attitude stability by -1, so that higher scores indicate greater attitude stability.

3.3. Attitude effects on eye movements and choice

As an initial check, we examined the correlations between our four attitude measures: extremity, accessibility, certainty, and stability. In most cases these correlations were negligible, except for the correlation between extremity and certainty, with a correlation of 0.35 (Fig. 3). In other words, the higher a participant's rating for an item, the more confident they were in that rating.

Our first main question of interest was how the four attitude features would affect relative dwell time between the two alternatives (we focus on relative dwell times, rather than gaze proportion, because that allows us to later look at the effect of individual dwells and directly compare these coefficients). To answer this question, we used a full mixed-effects linear regression of relative dwell time on rating difference, accessibility difference, certainty difference, and stability difference, all coded as left–right. This analysis revealed that the only significant predictor of dwell time was accessibility, with less accessible items (i.e. long YES/NO RT) receiving more attention ($\beta = -0.04$ s, $p = .003$; all other $p > .28$; Figs. 4, S6, Table S1). We confirmed this accessibility result with an additional paired *t*-test (mean difference = 0.023 s, d = 0.3, two-sided p = .01), which corresponds to a roughly 0.3% increase in choice probability based on the earlier regression of choice probability on dwell time.

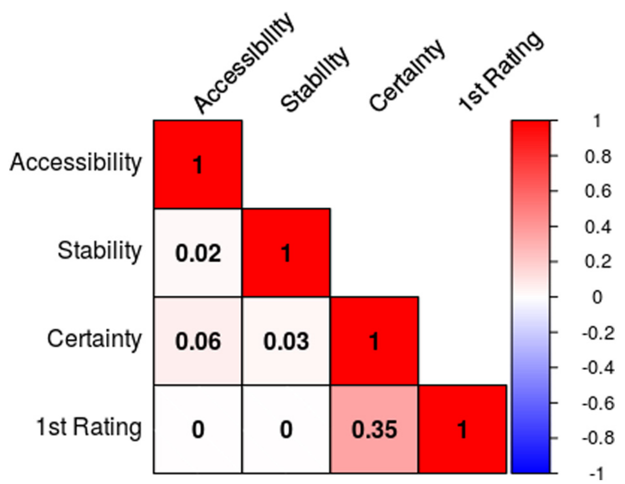

Fig. 3. Correlations between attitude measures. Each correlation was run for each individual and then averaged to generate these values. Significance for each correlation was assessed by testing the distribution of individual correlations against zero, and applying Holm-Bonferroni correction to the p-values. The p-values were as follows: stability vs. accessibility – p = .93, certainty vs. accessibility – p = .015, certainty vs. stability – p = .24, extremity (1st rating) vs. certainty – p = 10^{-9}. Since stability and accessibility were orthogonalized to the 1st ratings, their correlations with extremity are zero by definition.

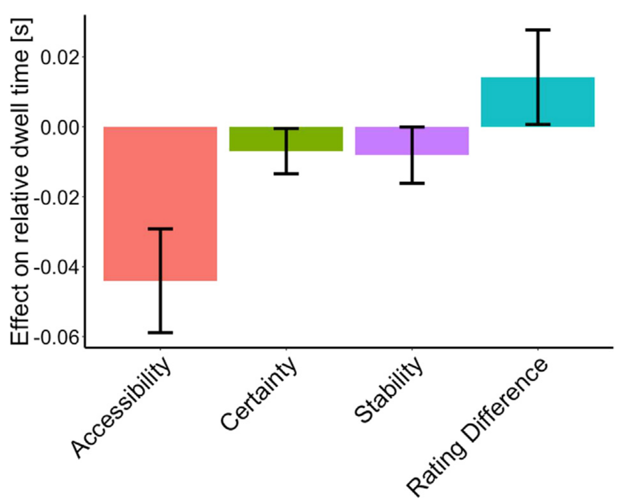

Fig. 4. The effect of accessibility on dwell time. Beta coefficients indicating the change in total relative dwell time, in seconds, for each unit increase in the difference in accessibility, certainty, stability and rating. When predicting left dwell time advantage from left- right rating difference, accessibility difference, certainty difference, and stability difference, the only significant predictor is accessibility. Subjects look at low accessibility items longer than high accessibility items. Errors bars are s.e.m.

In a follow-up analysis, we asked whether this effect of accessibility on dwell time was only present during the first dwell to each item, or was maintained throughout the decision. We ran full mixed-effects regressions of dwell time on accessibility using either the first two dwells (i.e. the first dwell to each item) or the later dwells. In these two regressions we controlled for the item ratings and dwell number, and excluded the final dwell in each trial since those are cut short by decision-boundary crossing. The item ratings and the unattended item's accessibility were never close to significant (all $p > .1$; Tables S2–S3) but dwell number was significant ($\beta = 0.151$ s, $p < .001$; $\beta = 0.026$ s, p = .033), confirming past findings that later dwells are longer.

For the first two dwells we found a significant effect of the item's accessibility on its dwell time ($\beta = 0.017$ s, p = .037). For later dwells this effect was also significant ($\beta = 0.053$ s, p = .029). Thus, we don't

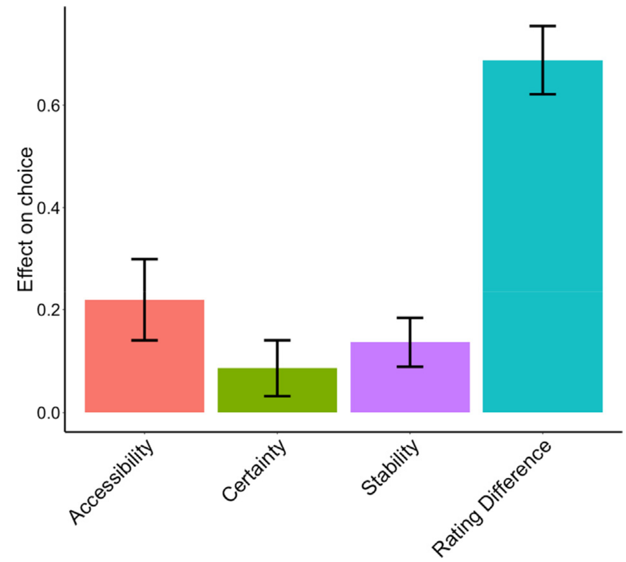

Fig. 5. The effects of accessibility on choice. Beta coefficients from a logistic regression, indicating the increase in choosing the left item for each unit increase in the difference in accessibility, certainty, stability and rating. Subjects chose consistently with their ratings as expected, but additionally chose items with more accessible and more stable attitudes. There was no effect of certainty on choice. Errors bars are s.e.m.

find any evidence that the cost of accessing the attitude is only paid up front.

Our second main question of interest was how the four attitude features would affect participants' choices. We used a mixed-effects logistic regression of choice (left = 1, right = 0) on rating difference, accessibility difference, certainty difference, and stability difference, all coded as left–right (see Supplementary material). This analysis revealed significant positive effects of rating ($\beta = 0.69$, $p < .001$), accessibility ($\beta = 0.22$, p = .006), and stability ($\beta = 0.14$, p = .004), but no effect of certainty ($\beta = 0.09$, p = .11) (Fig. 5, Table S4). In other words, a participant was more likely to choose an item if their attitude towards it was more positive, easier to access, and more consistent.

Taken together, these results indicate that while less accessible items attract more attention, they are less likely to be chosen. This suggests that prior estimates of the effect of dwell time on choice may be underestimated. In other words, if less accessible items attract more attention but are chosen less often, that would reduce the measured relationship between attention and choice. To test this hypothesis, we conducted an exploratory analysis, where we ran mixed-effects logistic regressions of choice on rating difference, dwell-time difference, and accessibility difference. We compared the coefficient on dwell-time difference between this model and the earlier model, without accessibility difference included. We normalized all regressors in order to directly compare the resulting betas. Without including accessibility difference, the coefficient on dwell time difference is 0.37 ($p < .001$). When accessibility difference is included, the coefficient on dwell time difference increases slightly to 0.38 ($p < .001$). Using a paired *t*-test between the subject-level dwell-time coefficients extracted from both mixed-effects regression models, we found that this increase was non-significant (difference in $\beta = 0.013$, p = .11). Thus, it appears that accounting for accessibility does not substantially change the estimated effect of attention on choice in this dataset.

Finally, our third question of interest was whether these three dimensions of attitudes (i.e. accessibility, certainty, stability) would impact how well participants chose in line with their subjective values (liking ratings). We expected that all three measures might increase participants' accuracy in the choice task, where accuracy is defined as choosing in line with the liking ratings. To test this, we ran a logistic

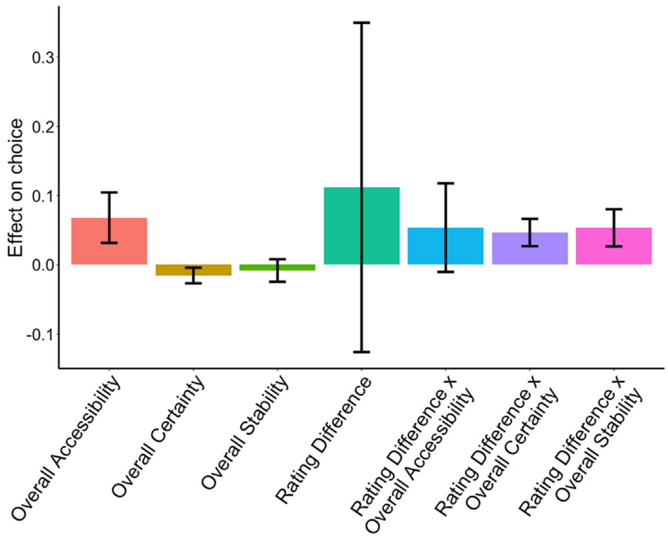

Fig. 6. The effect of overall attitude measures on choice. Beta coefficients from a logistic regression, indicating the increase in choosing the left item for each unit increase in the various attitude measures. On their own, overall accessibility, certainty, and stability did not predict choices ($p > .05$ on all coefficients). The coefficients on rating difference interacted with overall certainty and overall stability were both significantly positive, indicating that participants' choices were more in line with their ratings when certainty and stability were high. No such effect was observed for the interaction between rating difference and overall accessibility. Error bars are s.e.m.

regression (with clustered errors; a mixed-effects model would not converge, but yielded nearly identical estimates and p-values) of choice (left = 1, right = 0) on rating difference interacted with overall accessibility, overall stability, and overall certainty, where "overall" indicates left + right, i.e. the summed values for the two alternatives. In other words, we were interested in the average of these attitude measures, rather than the difference between sides. As expected, we found no significant simple effects with the exception of a marginal effect of overall accessibility (overall accessibility: $\beta = 0.07$ p = .06, overall stability: $\beta = -0.008$, p = .61, overall certainty: $\beta = -0.02$, p = .17); we have no reason to expect that overall accessibility (or any of the other measures) increases choosing items on the left-hand side. We also did not find a significant simple effect of rating difference ($\beta = 0.11$, p = .54), most likely due to the fact that this regressor captures the effect of rating difference when subjects have zero confidence in their ratings. However, while we did not find a significant interaction for accessibility ($\beta = 0.05$, p = .4), we did find significant interactions for stability ($\beta = 0.05$, p = .047) and certainty ($\beta = 0.05$, p = .018). Thus, both attitude stability and certainty appear to have increased participants' accuracy rates (Fig. 6, Table S5).

4. Discussion

In this study we combined eye-tracking with incentivized choices in order to examine the relationships between attitude characteristics, attention, and choice. We looked at measures of attitude extremity (positively valenced), accessibility, certainty, and stability. The only measure that seemed to affect the allocation of attention was attitude accessibility; participants dwelled longer on less accessible items. However, despite the overall positive relationship between dwell time and choice, participants were less likely to choose the less accessible items. On the other hand, certainty and stability had no obvious effects on attention, however higher levels of either measure correlated with more accurate choices.

Our work sheds new light on the foundational literature studying attitudinal influences on behavior. Our study also provides more specific insight into food choice, a topic of great importance in the current obesigenic environment, where it is critical to combat societal influences that lead to obesity and malnutrition (Mann et al., 2013). Additionally, food choices are often made in the presence of others or when considering others' preferences or the implications of one's choices for others. To the extent that these mechanisms also take place when other people are present or considered, understanding them should help to inform future work that addresses social contexts. Finally, our own past work has demonstrated great overlap between DDMs of food choice and social allocation decisions, providing a concrete link between decisions in these different domains (Krajbich, Hare, Bartling, Morishima, & Fehr, 2015; Smith & Krajbich, 2018).

Our findings also highlight an important qualification to prior work on the link between attention and choice. While some have argued that more attention is always beneficial (Cavanagh et al. 2014; Stewart et al. 2016; Towal et al. 2013), others have argued that the effects of attention depend on the attitudes towards the choice options (Smith & Krajbich, 2019). This latter work argues that attention amplifies attitude information and so has beneficial effects for positively valenced information but detrimental effects for negatively valenced information. For example, when choosing between disliked items, more attention to an item leads to a lower likelihood of choice (Armel et al., 2008). In a similar way, items whose attitudes are harder to access may not benefit enough from the extra attention that they receive to offset the weakened input. If we examine this from an aDDM framework, this could indicate that the boost in evidence accumulation for the attended item may depend on the accessibility of that item. In a traditional framework, the unattended item is discounted by a fixed multiplier, but it's possible that this attentional discounting parameter could change depending on the accessibility of the currently unattended item. In fact, some models have included separate attentional modifiers for each item, which offers an avenue through which to explore the possible correlation between these separate attentional discounting parameters and the accessibility of the items (Fisher, 2017).

Why should low-access items attract more attention? One suggestion comes from the literature on perceptual decision making. For instance, Cassey et al. (2013) argue that when comparing two noisy perceptual stimuli, one should attend more to the noisier stimulus, in order to equate one's certainty about the two options. Indeed, they find that people do attend more to the nosier options. In a similar way, one might want to focus more on the less accessible item in order to give it a fair chance against the more accessible item.

Surprisingly, accessibility did not seem to increase decision accuracy, that is participants were not more likely to choose in line with their ratings when overall accessibility was high. This runs counter to past work by (Fazio, Powell, & Williams, 1989). However, participants were more accurate when certainty and stability were high. This suggests another important distinction between these features of attitudes. Given the nature of accessibility, it is perhaps not surprising that it does not facilitate accuracy. Accessibility merely affects the speed with which information is retrieved, possibly giving the more accessible item a head start (and thus a choice advantage), but not having any effect when both alternatives are high or low. Our results on stability are also in line with recent work that argues that variability in subjective-value reports are a key determinant in choice accuracy (Polanía, Woodford, & Ruff, 2019). Our results on certainty are also consistent with prior studies that have shown that there is a correlation between certainty and attitude-behavior consistency (Berger, 1992; Berger & Mitchell, 1989; Shanker Krishnan & Smith, 1998).

One point worth making about attitude accessibility: the way we measured accessibility (Fazio et al., 1989; Fazio & Dunton, 1997; Roskos-Ewoldsen & Fazio, 1992) is somewhat problematic because it relies on YES/NO RTs, which we have shown are correlated with the liking ratings. In other words, if a participant quickly says yes to an item, it could be that their attitude is very easy to access, but it could also be that they just have a very positive attitude towards that item. In our analyses we tried to account for this by using residual YES/NO RTs, after controlling for the elicited liking ratings. However, these liking ratings are noisy and so may not be perfect controls. Thus, it is possible that our measure of accessibility still contains some information about liking. This could explain why we found that shorter YES/NO RTs led to a higher probability of choice. On the other hand, while we found that items with longer YES/NO RTs attracted more attention, we found no such relationship between liking and attention. This indicates that our residual YES/NO RT measure is not simply capturing liking.

To conclude, our study links two literatures on attitude-behavior consistency and gaze-weighted evidence accumulation in simple choice. Our results mirror past work linking attitude certainty and stability with attitude-behavior consistency, but using a relatively large set of incentivized choices. Our results also suggest that attitude accessibility has different effects on attention than previously thought, in a way that is more in line with prior work in perceptual choice. This finding highlights the benefits of adopting an interdisciplinary approach and using process data, in this case eye-tracking data, to study behavior. Indeed, including accessibility measures into analyses on attention may help shed light on the processes behind how we choose to allocate attention to different items, and how attention then guides choices. This can increase the predictability of decisions, and offer greater control of attention allocation in preference-based eye-tracking studies by selectively equating accessibility, and thus reducing noise in eye-tracking data due to unmeasured attitude accessibility. This research just scratches the surface of the potential similarities between lower level cognitive processes, such as using attention to optimally sample from noisy displays, and more complex processes, such as subjective decision making.

Prior publication

The choice data in this manuscript were published as part of an unrelated meta-analysis in Smith and Krajbich (2019).

Funding

This work was supported by the National Science Foundation, United States Career Grant 1554837.

Open practices

The data and stimuli for this manuscript are available at https://osf.io/dqv2n.

Acknowledgments

We would like the thank Ken Fujita, Duane Wegener, Rich Petty, and Russ Fazio for their invaluable input and feedback on this project.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jesp.2019.103892.

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