***Reviewers' comments:  
  
Reviewer #1 (Remarks to the Author):  
  
The authors have done an excellent job in the revision and the paper has substantially improved. By adding further analyses and model comparisons, further discussions and an additional study, they addressed all but one my concerns. Also, it is great that the new study used state of the art pre-registration, although other techniques would have been available to better manipulate attention (eye-tracking studies like used in most of the recent work: Ghaffari & Fiedler, 2018, PsySci).  
In some points, I am not fully following the author’s arguments, but these points concern issues that should probably be discussed not in a review process but in an open debate in future publications.***

We thank the reviewer for their encouragement and will incorporate their suggestions for references to relevant literature. We very much look forward to the open debate suggested, and hope it will lead to a better understanding of these interesting phenomena! ***There are a few remaining issues that should be addressed:   
- The authors misunderstood my second point: “2) Internal validity: One alternative explanation for the behavioral results would be that the 3 spontaneous responses are more noisy and people who behave more extremely show regression to the mean if more time is available.” – I do not doubt that results are more noisy under time pressure (as the results in the authors responses suggest) – but my argument is that if the authors select /classify persons based on extreme responses in a noisy environment, there will be a stronger regression to the mean effect if they measure the same variables again. The authors have to address this major point in the main text and to rule it out (perhaps they can with the new study). My suggestion to use an independent measure of social preferences (e.g. SVO measure) pointed in the same direction: when the person’s classification is based on an independent measure, the point can be ruled out.***

We apologize for our misunderstanding of the reviewer’s original comment. We now fully appreciate and agree with the reviewer’s concern. However, we think it is unlikely that the effects here are driven by regression to the mean. One of the key issues determining the likelihood of observing a significant regression to the mean effect is the extent of measurement variability: the higher the variability, the more likely regression to the mean. In this regard, while we describe generosity as a single measure in the two separate conditions, we wish to note that it is actually a composite across many repeated measurements (80 trials per condition). Hence, the mean estimates of generosity in either condition are likely to be relatively close to the “true estimates” (Barnett, Van Der Pols, & Dobson, 2005) given the small possibility that random within-individual variability could result in consistent selfish/generous responding across 80 trials. To this point, we find excellent reliability across blocks (20 trials each) in generosity estimates for each condition:

Table 1: Reliability of generosity estimates across blocks for each condition in 3 studies.

|  |  |  |  |
| --- | --- | --- | --- |
| **Study** | **Number of blocks** | **Cronbach’s  [95% CI]** | |
| **High time pressure** | **Low time pressure** |
| Study 1 | 4 | 0.94 [0.91, 0.96] | 0.92 [0.90, 0.96] |
| Replication Study 1 | 5 | 0.93 [0.91, 0.96] | 0.92 [0.90, 0.95] |
| Replication Study 2 | 5 | 0.95 [0.93, 0.97] | 0.95 [0.92, 0.97] |

To get some sense of the likelihood that our effects are simply due to regression to the mean, we re-ran the same correlational analyses we performed on the full set of trials investigating the association between generosity under high time pressure and change in generosity with time, but now separately for each block. We find overwhelming consistency in the pattern of effects across all blocks (Study 1: mean Pearson’s r = -0.398, all *ps* < .01; Replication Study 1: mean Pearson’s r = -0.455, all *ps* < .05; Replication Study 2: mean Pearson’s r = -0.390, all *ps* < .05) Thus, we think it is highly unlikely that random variability in estimates resulting in regression to the mean would exhibit such consistency across multiple tests and experiments. Together, these new analyses strongly suggest that individuals do exhibit a unique pattern of choice biases under time pressure that are mitigated with time.

We also performed an even stronger test of regression to the mean vs. our favoured hypothesis. Assumptions of regression to the mean suggest that the strongest drivers of the effect would be the most extreme predictors (since these are the observations that can shift the most towards the mean). In contrast, our prioritized attention model suggests that the most extreme individuals (ones who attend 100% of the time to self or to other exclusively) should actually be *least* likely to shift in a more moderate direction, since they are better able to implement their true preferences. It should actually be the individuals who give at least *some* weight to the secondary attribute, and attend to it when given enough time, who show the most change. Thus, the regression to the mean explanation suggests that observed associations between generosity and change due to time pressure should get weaker when the most extreme individuals are excluded, whereas our model predicts that this association should stay the same, or if anything get stronger. To test these two distinct possibilities, we ran a follow-up analysis excluding participants who were < 25% generous or > 75% generous under time pressure. Instead of attenuating the original effect (Study 1: Pearson’s r = -0.313, t58 = 2.513, p = .0148; Replication Study 1: Pearson’s r = -0.286, t63 = -2.3702, p = .021; Replication Study 2: Pearson’s r = -0.300, t47 = -2.1537, p = .036), we find that the effect becomes stronger when excluding the participants most likely to regress towards the mean (Study 1: Pearson’s r = -0.490, t35 = -3.326, p = .0021; Replication Study 1: Pearson’s r = -0.408, t52 = -3.221, p = .0022; Replication Study 2: Pearson’s r = -0.522, t32 = -3.459, p = .0016).

This effect is fully consistent with our subsequent analyses that show individuals’ gaze biases to be particularly important in mediating this effect. For example, extremely selfish individuals typically make consistently selfish choices under low time pressure as an expression of their selfish social preferences. Under high time pressure, they are also likely to search exclusively for their own outcomes first, ensuring that their selfish preferences are sustained and expressed. Thus, we observe no change in their behavior. In contrast, moderately selfish individuals, while still preferring to maximize their own outcomes, also give some attention to others’ outcomes under low time pressure. Under high time pressure however, because they are more likely to search for their own outcomes first, and then have little time to acquire and process the other person’s outcomes, their choices become more extreme reflections of their underlying preferences. Given these arguments, we do not believe it is necessary to employ an independent measure of prosociality, like the SVO, to illustrate this point.

Finally, our model cross-validation strongly suggests that the individual-level parameters estimated from half of the data is sufficient to predict patterns of change in choice behavior under time pressure in an out-of-sample dataset. These systematic associations between social preferences, attention and choice would be highly unlikely in an account of choice that simply assumes regression to the mean. We now report these analyses as part of supplementary note 1 and make mention of it in the main paper in the results section (Pg. 8).

***- The authors note that they will provide the code and the data (only on) reasonable request. According to current standards of transparency, they should be made directly available at OSF.***

While we agree with the reviewer and editor that direct access to all code and data would be ideal for purposes of transparency, the data reported in the in-lab studies were collected at a time when such practice was not yet standard (which we note with amazement was not such a long time ago!). As a result, the ethics protocols under which this data was collected only permits sharing of participants’ data upon reasonable request to the author. We have submitted an amendment to the relevant ethics committee to obtain permission to make the de-identified data available on an OSF repository as requested. Should this amendment be approved before publication of the paper, we will update all relevant references to include a link to the data. The code will be made publicly available at the following link: <https://osf.io/vf6a5/> following acceptance of the manuscript. We have included this link on pg 42 of the main paper. Here is a corresponding view-only link to the repository: <https://osf.io/vf6a5/?view_only=d0ca47b6abe441b59765f29df9611272>.

***- For the new study, the frequency with which all information was inspected should be reported in the main text and the analysis should also be run with only the trials in which all pieces of information are inspected. It is crucial that the results are not only driven by the fact that people do not look at the other outcomes.***

We agree with the reviewer that it is important to know which of the multiple possible mechanisms through which attention interacts with time pressure to affect the decision-making process. It is in fact *precisely* this point that we are trying to make: that time pressure can both amplify attentional biases to acquire certain pieces of information search, and then can also truncate the search process before all information has been fully comprehended. As we originally state on pg. 4, “Such a model is consistent with research showing that selfish individuals attend more to information about self-interest while prosocial individuals attend more to information about the welfare of others, but goes a step further in suggesting that time pressure (which may force individuals to make fast rather than fully-informed choices) should amplify the strategic deployment of attention towards information prioritized by the individual.” Thus, our model actually explicitly predicts that the primary driver of behaviour change under time pressure should be the combination of where an individual looks first (due either to endogenous preferences or exogenous cues) and whether they acquire any further information. Our model further suggests that people should be more strategic under time pressure, both about what information they acquire first, as well as whether and when they acquire additional information. The results of both Studies 1 and 2 are fully in line with this theory.

In our second study, we find that participants were indeed less likely to inspect all information under high time pressure (Mhigh = 75.32%) than low time pressure (Mlow = 93.02%). Mixed effects logistic regressions revealed this difference to be significant (*b* = 2.322, SE = 0.0519, z = 44.77, p < .001). This effect is also true of Study 1 (Mhigh = 87.92%; Mlow = 98.00%; *b* = 2.567, SE = 0.1399, z = 18.35, p < .001).

Moreover, in Study 2, we find that people show evidence of strategically deciding whether to acquire additional information after their first fixation, especially under time pressure. For example, our model suggests that, if people are selfish, they should feel less need to acquire additional information under time pressure when what they are forced to look at corresponds to their already-preferred information (i.e. self-outcomes), but should be more likely to prioritize additional information search if we force them to look at less-preferred information. This predicts that people should show fewer fixations to distinct information when they acquire their preferred information first, and this should be especially true under time pressure, which makes information acquisition more costly. Mixed effects generalized-poisson regression on number of fixations as a function of time pressure and first fixation confirmed this prediction. Participants were more likely to make fewer fixations in a trial if they were forced to looked at self-outcomes first (Low time pressure: *b* = -0.034, SE = 0.005, z = -6.88, p < .001), and this effect was significantly stronger under time pressure (High time pressure: *b* = -0.131, SE = 0.006, z = -21.81, p < .001; Interaction: *b* = -0.097, SE = 0.008, z = -12.63, p < .001).



Figure: First fixation position and time pressure interact to predict the total number of fixations on a trial. The middle line of the box-plot indicates the group mean number of fixations per trial with the upper and lower boundaries of the box indicating +/- 1SE. The violin plots indicate the distribution of participants’ mean number of fixations per trial.

Together, these analyses suggest that individuals were more likely to expedite their choices at the expense of incomplete information search under high time pressure. Furthermore, participants sacrificed additional information in a strategic way such that they were more likely to make choices based on incomplete information when they had already acquired what we assume to generally be the highest-priority information, namely, their own outcomes.

This findings are fully in line with one of the main aims of our paper, which is to show that the effects of time pressure on generous choice may be mediated through strategic shifts in attention, and that these strategic aspects of choice may provide a better, more parsimonious alternative explanation that help to resolve the existing conflicts in the broader literature. Given this scope, we think that the observation that time pressure induces biased and incomplete information search is actually supportive of our arguments regarding the dynamic role of attention and its influence during choice behavior under constraints.

However, we also share an interest with the reviewer in knowing whether our results are *fully* explained by what we might think of as time-pressure induced ignorance, or also result from incomplete incorporation of that information due to attention. This question relates to existing views of the literature on attention and choice, which have suggested that the main ***causal influence*** of attention on choice is its role in the initial acquisition of relevant information (see: Orquin & Mueller Loose, 2013).

To address this question, we ran a third on-line experiment in which we presented information serially in the dictator game and interrupted participants at different points in their viewing to elicit their choice. In each trial, participants (N = 103) were first presented either their own outcomes ($Self) or their partner’s outcomes ($Other) for ~300ms. They were then presented the other piece of information ($Other or $Self). In three conditions, participants were presented the second piece of information for either 100ms, 200ms or 400ms before they were interrupted and prompted to make their choice. In the other two conditions (which we refer to as repeated-fast, and repeated-long), participants were presented both pieces of information twice. In the repeated-fast condition, participants were presented with information in the following order: 1st (~300ms), 2nd (~300ms), 1st (~300ms), 2nd (200ms) before being prompted to make a response. In the repeated-long exposure condition, participants were also presented with both pieces of information twice but for longer durations, such that they are presented with information in the following order: 1st (~500ms), 2nd (~500ms), 1st (~500ms), 2nd (500ms) before prompted to make a response.

Since in all conditions participants were exposed to both information (i.e., $Self and $Other), the ignorance model of attention would predict no effect of attention on choice while the attentional amplification model would predict that the focus of early attention would bias choice but its effects should weaken as people sample more information. Additional preregistered experimental details, hypotheses and analyses can be found on OSF at the following link: <https://osf.io/hw9um/?view_only=6c70927f1f144b20b96f18cac1808958>.

Importantly, using mixed-effects logistic regressions predicting binary generous choice, we find an interaction between the first information presented (first fixation) and 2nd information exposure conditions (Wald’s 2(4) = 20.621, p < .001), such that first fixations predicted generosity when exposure to the 2nd piece of information was relatively short (100ms: *b* = -0.476, SE = 0.0857, z = -5.560, p < .001; 200ms: *b* = -0.209, SE = 0.0863, z = -2.416, p = .0157) but not when participants were exposed to the 2nd information for extended periods of time (400ms: *b* = -0.074, SE = 0.0898, z = -0.828, p = .407; repeated: *b* = -0.086, SE = 0.0889, z = -0.972, p = .331; repeated-long: *b* = 0.040, SE = 0.0887, z = 0.457, p = .648). This pattern of results not only replicate findings in Study 2, but also suggests that ignorance cannot fully explain the effects of early attentional biases on choice.



Figure: First fixation position and 2nd information exposure condition interact to predict the total number of fixations on a trial. The middle line of the box-plot indicates the group mean number of fixations per trial with the upper and lower boundaries of the box indicating +/- 1SE and the whiskers indicating the 95% confidence interval.

Although we think these results are interesting, and support *both* the effects of ignorance and the effects of attention on time-pressure induced biases, we believe they deserve their own, more thorough treatment and are thus working to prepare a second manuscript examining these results further, with additional experiments. Given that the paper is already somewhat long as is, we have therefore currently opted not to include an extensive discussion of these findings in the current article. However, if the editor or reviewer feels that this would be crucial to include, we would of course be happy do so, either in the main body of the paper or in a supplementary note. To highlight the fact that this issue is an important one for future research, we have made the following changes to the Results and Discussion sections of the paper:

Results: The Gaze-Informed Attentional Drift Diffusion Model

“Unlike previous applications of the ADDM, which model attention generically using group or trial averages (Krajbich, Armel, & Rangel, 2010; Krajbich & Rangel, 2011; Smith & Krajbich, 2019), our model makes full use of information about each individual’s moment-by-moment gaze position to determine whether and when different attributes enter consideration in the decision process (Orquin & Mueller Loose, 2013) and when they receive amplification by attention.”

Discussion:

“Furthermore, the exact mechanisms through which attention influences the evidence accumulation process remains to be fully elaborated. Some existing work suggests that attention has its primary effect by determining whether information is processed at all, while other work posits that attention amplifies the value of evidence in real-time. While we have included both these possibilities as attentional mechanisms in our computational model, researchers continue to debate the relative contributions of these mechanisms during choice (Ghaffari & Fiedler, 2018; Orquin & Mueller Loose, 2013; Smith & Krajbich, 2019). Future work should seek to characterize and disambiguate between these mechanisms of attention and their downstream effects on choice, both in the domain of social decision making and beyond.”

***- The findings of the Ghaffari & Fiedler (2018) paper should be discussed since it provides the most similar work to the newly included study that manipulates attention to influence social preferences.   
  
Ghaffari, M., & Fiedler, S. (2018). The Power of Attention: Using Eye Gaze to Predict Other-Regarding and Moral Choices. Psychological Science, 29(11), 1878-1889.***

We thank the reviewer for the reference. We now include a reference to this paper in the overall discussion (Pg. 25).

***Reviewer #2 (Remarks to the Author):  
  
The authors have fully addressed my comments on the manuscript. The detailed and thoughtful replies are appreciated!***

We thank the reviewer for their encouraging remarks. ***Reviewer #3 (Remarks to the Author):  
  
I thank the authors for their very comprehensive replies to my comments. It was particularly thoughtful of them to run a follow-up study to address one of my concerns. I have no lingering worries about the paper and believe it would make an excellent contribution to the journal.***

We thank the reviewer for their encouraging remarks.