Lotje van der Linden

Aix-Marseille Université / CNRS

Laboratoire de Psychologie Cognitive

3 Place Victor Hugo

Centre St. Charles, Bâtiment 9, Case D

13331 Marseille

France

[l.vanderlinden@cogsci.nl](mailto:l.vanderlinden@cogsci.nl)

Subject: Cover letter for the revision of our Manuscript ID JOV-04373-2014 - "The Role of Object Affordances and Center of Gravity in Eye Movements Towards Isolated Daily-Life Objects"

Dear Dr. Kowler,

Herewith we submit our revised manuscript ID JOV-04373-2014 - "The Role of Object Affordances and Center of Gravity in Eye Movements Towards Isolated Daily-Life Objects". We would like to thank yourself and the reviewers for your time and constructive comments. We believe that we addressed the concerns raised by the reviewers and yourself, and that these changes have substantially strengthened the manuscript. We sincerely hope that we addressed all comments to your satisfaction.

# Reviewer 1

## Major

1. “(…) the basic eye movement data is difficult to interpret in terms of absolute landing positions, since no control objects were used, e.g. non recognizable 2d shapes that overall have the same visual characteristics as the real object shapes.”

We thank Reviewer 1 for this suggestion. We carried out a new experiment in which we compared landing positions towards real objects with landing positions towards non-objects that were matched to the real objects' shape, texture, and asymmetry (line ….).

2. “(...) the distinction in data analysis between 'relative to image center' and 'relative to centroid' is opaque. I feel that what the default landing position on a shape under this task paradigm should have first been established with non-functional shapes of the same basic visual parameters before testing the real objects.”

We agree with both Reviewer 1 and Reviewer 2 (see below) that the comparison between landing positions relative to the stimulus' absolute center versus its CoG, was not transparent and convincing enough. In addition, when designing our new experiment (see point 1), we realized that we made a small mistake in the way we aligned the stimuli in our original Exp 2. Therefore, we made two important changes to our manuscript. Firstly, we replaced the “old Experiment 2” with our new experiment. Secondly, we reserved a more modest role for our CoG calculation, by simply treating it as one of the controls that we added to Experiment 2. (See also response to Reviewer 1's point 5.)

3. “(...) the study did not take standard methodological care, e.g. altering start fixation and/ or object location in the horizontal dimension. (…) This could have been done on a radial arrangement.”

We thank Reviewer 1 for this suggestion. In the new experiment, we used a radial arrangement in which the stimulus could appear at an angle of 0, 20, 160, 180, 200 or 340° (see line... ).

4. “The main finding, that secondary saccades are directed to the action performing side is confounded by the fact that the very task authors gave the subjects is expected to produce the outcome. All the objects had 'handles' whose identity has to be determined by looking the action performing side.”

We agree with Reviewer 1. Therefore, in the new experiment we asked participants to simply indicate whether the stimulus was a real object or a non-object (line ….). For this task, there seems no reason to think that one part of the object is more crucial for the task than other parts.

## Minor:

5. “I don't understand why two modes of eye position analysis was required as error vs. centroid, and error vs. image center.”

As mentioned above (point 2), we agree with both reviewers that it is better not to directly compare these two analyses with each other (e.g. in order to determine which of the two predicts landing positions best). In Experiment 2, we still used our CoG calculation, but now treated it as one of the controls that we added to this experiment (as compared to Experiment 1) to rule out the possibility that the gaze bias towards the objects' action-performing side is explained by low-level stimulus features.

6. “Data presentation in Figure 3 and 6 I found to be unusual and confusing. Isn't everything we need to know on figure 4 and 7 anyway?”

We agree with Reviewer 1 that there was redundancy between these plots. Still, we do think that, in general, distribution plots and “time-course” plots do add unique information. The distribution plots help us determine whether average landing positions come from a bimodal or unimodal distribution, which is crucial for the interpretation. “Time-course” plots do not provide this information. In contrast, “time-course” plots show the results of our LME analyses and visualize landing positions as a function of saccade latency. This enables us to visualize how the effects build up over time.

To remove any redundancy, we removed the 'time course' element from the distribution plots, by plotting only overall distributions rather than three separate distributions for early, medium and late saccades. We feel these plots are indeed more readable now.

# Reviewer 2

## Major

1. “Distinction between center of objects vs. CoG hypotheses is weak whereas conclusions are overly strong.”

a.) “The PVL account is dismissed as "lacking specificity" (...) Surprisingly then, the Results are set up as a comparison between CoG and object center. (…) Ad "lacking specificity of PVL": This is true to a certain extent. Though one could derive the prediction that object center should be the intended target for both "symmetric" and "asymmetric" objects while pointing out that most objects in real life are probably "symmetric". (…)

We don't have precise information about how much object center (OC) and CoG differ from one another for the "asymmetric" objects. (…)

“The fact that the direction of gaze reversed depending on the reference point argues against a high-level, object-based effect.". First of all, the authors are overstating their case because only the very short latencies show a bias toward the handle side when CoG is taken as reference. More importantly, I don't understand this argument (…).

"When saccade latency was low, the eyes were drawn towards the CoG" contradicts Figure 3, which shows that the very quick saccades hit object center. (…)

In sum, the logic and data are rather weak with reg. to CoG vs. OC. I suggest clarifying the logic and tone down the conclusions.”

With regard to the hypotheses: We agree with Reviewer 2 that the saccadic-averaging account and the PVL-as-a-strategy account make very similar predictions. We changed the manuscript accordingly: We now mention the similarity in predictions explicitly and we now don't try to distinguish between both accounts any more. Instead, we group them together under one common hypothesis, and interpret the fact that early saccades do not show any bias towards either side of the object, as evidence for this “grouped” hypothesis.

With regard to the absolute-center-vs-CoG analyses (see also responses to Reviewer 1): We agree with both reviewers that the reasoning behind the comparison between LPs relative to the absolute center vs CoG was not transparant, and that the results from this comparison were not sufficiently convincing. In the current manuscript, we do not compare both reference points anymore. We merely use our CoG calculation in Experiment 2 to exclude the possibility that the gaze bias towards the action-performing side, which we interpret as an affordance effect, is due to overall asymmetry of the tools that we used as our stimuli.

c.) “See also "PVL paper" by Pajak & Nuthmann (2013), (...)”

We now refer to this in the manuscript (line... ).

d.) Comment (doesn't need to be addressed in manus): in the real world, we typically don't process objects in isolation. From that point of view, center-of-gravity saccade averaging \*within\* objects is less interesting. The more pressing question is whether CoG averaging takes place with regard to groups of objects in the scene (see Pajak & Nuthmann, 2013, for some speculations).

2. ) “Conceptualization and calculation of CoG. While the manuscript is, in many aspects, very detailed, computation of the CoG (briefly summarized in an Appendix) lacks motivation and detail.”

a.) Conceptually, how is "CoG" defined for the objects? Technically, explain the Sobel operator in one or two sentences. Explain what "weighted average contrast" refers to. How exactly do we get from there to the CoG? This would be worthwhile to visualize as well.

It says that "on average, the CoG of our stimuli was shifted (by about 1.25% of the object's width) towards the action-performing side". What is the reference point here - the center of the object image? That would imply that CoG and center of object only differed by, on average, 0.065 deg (assuming an average object width of 5deg, p. 12), which would be very small and below the accuracy of the eye tracker.

How does the method applied here compare to methods used in other papers (in particular the ones cited on p. 8, bottom)?

Although in the revised manuscript our CoG calculation plays a much less dominant role, we now provide these details in Appendix A.

e.) In Figures 1, 2, 5: does CoG in the respective figure represent the true CoG of the respective object? Since the stimulus set only comprised 14 "asymmetric/handled" objects, one possibility is to present miniature versions of them in an Appendix or Supplement (no charges), including a marker of both object center and the computed CoG.

In the previous manuscript, the CoG in these Figures was indeed exaggerated for the sake of visualization. Because we changed our approach with regard to our CoG calculation, the “old” Figures 2 and 5 do not appear in the revised manuscript. The arrow in Figure 1 is not based on a calculation. We now added an Appendix showing all stimuli and their CoG as we calculated it.

g.) CoG surely must have a vertical component as well? Restricting analyses to horizontal lp only is sufficient for testing affordance hypotheses, but inferences with regard to CoG vs. OC targeting require two-dimensional analyses of landing positions as objects are two-dimensional entities.

TODO: Say something about this “shortcoming” in the GD??

## Minor:

4.) “Additional literature: sure this paper is about isolated object, but recent research has investigated lp within objects in embedded in naturalistic scenes in considerable detail. This is mentioned here with a few words only. Given that the manuscript addresses object targeting, and given the relevance of the PVL hypothesis, the results from object-in-scene studies deserve more detailed mention.”

We agree with Reviewer 1 that the previous literature on PVL in objects in scenes is crucial for our manuscript. We now elaborate on them in the Introduction (line ...).

5.) “Information about the eye tracker's accuracy should be provided”

We now do so in the Methods section of Experiment 1 (line ...).

6.) “The Brodeur objects at least have white borders of varying sizes, were they cut off?”

Yes. We indeed used bounding boxes around the stimuli. We now specify this in the Methods section of Experiment 1 (line ...).

7.) "This enabled to control for any potential overall bias towards one side of the screen"-> there is indeed a bias for the first saccade to go more often to the left than to the right side of the image (see Nuthmann & Matthias, 2014), though this is only found in right-handers (Ossandon et al., 2014).

We thank Reviewer 2 for providing us with these references and now cite them (line ...).

“What is the random-effects structure of the linear mixed models? Were random slopes for subjects and items for "saccade latency" (the only significant fixed effect) included? Models with by-intercept random effects only aren't any good (Barr et al., 2013).”

Again, we thank Reviewer 2 for pointing our attention to this interesting paper. We now added random slopes to our LME models. We detail this in the Result section of Experiment 1 (line ...).

8.) “p. 17 states that the effect of "object orientation" (relative to handled side of the object) wasn't included as fixed effect in the lme. If I understand correctly, it is represented by the intercept in the model. If so, it/the intercept should be included in Tables 1 and 2, incl. t values and p values (which are currently missing in the text). Given the normalized landing positions, a significant intercept indicates a significant deviation of landing position from the respective point of reference (object center or CoG).”

Our reason for not providing the intercept in the Tables nor the text, was that the reference value of the factor Saccade Latency (0) does not seem informative. Instead, we use CI 95% (based on the function's intercept and SE) to interpret landing positions relative to the reference point. We now make this reasoning explicit in the Results section of Experiment 1. Yet, for the sake of completeness, we also include information about the intercept in the tables.

9.) “(...) Is targeting object center really a "top-down strategy", especially when the task is as simple as moving the eyes up or down to an isolated object?”

We agree with Reviewer 1 that interpreting the GE (for landing positions towards two stimuli) and the PVL (for landing positions on objects) as a visuomotor strategy rather than a default mechanism, does not make such eye-movement behaviour a “top-down strategy”. Instead, regardless of the underlying mechanism, we consider such eye-movement behaviour “low-level”, at least compared to moving the eyes in the direction of the action implied by the object. In the revised manuscript, we phrase our reasoning accordingly (line …).

10.) Editorial and language (not reprinted here).

We thank Reviewer 2 for these suggestions and for spotting these typos. We applied/ corrected them.

Kindest regards,

Lotje van der Linden

Sebastiaan Mathôt

Françoise Vitu