

Dear Dr. Karakashevska,

We have received reviews from two of our original reviewers and one new reviewer. Each reviewer carefully examined the Stage 2 submission against the Stage 1 IPA and felt the authors adhered to the original study design from the Stage 1 well.

Dr. Guillaume Rousselet had some suggestions on the reporting of the data. Specifically, Dr. Rousselet requested the behavioral results reported on page 21 be plotted using scatterplots, revealing the distribution of individual effects. They provided an editorial to illustrate graphical representations of such data. For figures 8, 10, and 11, Dr. Rousselet also requested the authors plot the individual subject data, revealing the data in its entirety. We agree the variability in the data is not currently illustrated and support this suggestion. Dr. Rousselet has outlined suggestions for how this might be done for each figure. Finally, we also wanted to address Dr. Rousselet's suggestion of removing the inferential tests in the exploratory analysis section. At PCIRR it is standard that the inferential tests are included in the exploratory analyses. Their evidential weakness compared to the pre-registered analyses is made apparent by being listed explicitly as exploratory.

We have followed Dr. Rousselet recommendations and added representations of variability to the results figures. As suggested, we have kept the inferential tests in the exploratory analyses section.

Further, the abstract and discussion of the manuscript should focus on the preregistered analyses.

We have focused the abstract by stating:

Contrary to our pre-registered hypotheses, perspective cost was uniform across all four blocks.

Anonymous reviewers 1 and 2 were content with the authors representation of their findings and provided some grammatical suggestions. Anonymous reviewer 1 also requested the authors revisit the paragraph starting “Given the current results...” on Page 27 to clarify their conclusion of the existence/absence of extraretinal representations and how it relates to the data in the Stage 2.

This paragraph covered some important considerations about optic invariants, but it perhaps required elaboration. To focus the discussion on the pre-registered results, we have removed it.

Please submit a point-by-point reply to our reviewers and revise your manuscript accordingly.

Best,

Grace & Zoltan

I would like to express my gratitude to the reviewers and recommenders for their detailed feedback and input, which greatly improved the registered report. Their insights have significantly strengthened the report. Below, we address the reviewers’ comments and our responses to their suggestions.

Anonymous reviewer 1

The manuscript, entitled "Putting things into perspective: Which visual cues facilitate automatic extraretinal symmetry representation?", by Elena Karakashevska, Marco Bertamini, and Alexis D.J. Makin, the authors addressed issues raised by the reviewers. This manuscript is a Stage-2 registered report. The authors collected data, analyzed the data, and reported the results with following the registered procedure. The authors conducted some additional exploratory analyses. The additional analyses are rational and they are clearly separated from the planned analyses in the manuscript.

I also found that the reported results and the authors' discussion on the results are interesting. I only have a few very-minor issues.

P. 20. > *In each block, we obtained obtain ...*

I think "obtained obtain" is a typo.

Fixed

P. 22. *Figure 8.*

The description of the left two columns of the figure is missing.

This is now Figure 9. We have updated the description of the figure 9 to read as follows:

***“Figure 9. ERPs from the posterior electrode cluster. Rows correspond to blocks. The leftmost column illustrates the ERP waves for frontoparallel asymmetry (green) and frontoparallel symmetry (purple) with the symmetry-asymmetry difference superimposed (grey). The central column illustrates the same data for the Perspective conditions. The rightmost column presents the SPN and perspective cost as difference waves. The SPN was consistently larger (more negative) for frontoparallel (black) compared to perspective (grey) presentations, with a similar perspective cost observed across all four blocks (red). The 300-600 ms interval used in statistical analysis is highlighted (yellow).*”**

P. 25. > *... differences significantly less than our ...*

Less than?

Fixed.

P. 27. > *Given the current results, we considered whether the brain ...*

This paragraph is not very clear. It will be great if the authors can revise the paragraph to fill the leaps of logic in the paragraph. From which part of the reported results, the authors considered the existence/absence of “extraretinal representations” in the visual system? The relationship between the ecological approach and the invariants is

missing. The sentence about the “perceptual experiences check” is important for the conclusion of this paragraph but the sentence is not very clear.

This paragraph covered some important considerations about optic invariants, but it perhaps required elaboration. To focus the discussion on the pre-registered results, we have removed it.

Dr Guillaume Rousselet

PCIRR-Karakashevska-stage2

Peer Community In Registered Reports Putting things into perspective: Which visual cues facilitate automatic extraretinal symmetry representation? [Stage 2 Registered Report]

Congratulations to the authors for successfully completing their project. I have carefully checked the stage 2 submission against the IPA version, and the main assessment criteria have been met. My only concern is whether inferential statistics should be reported at all in the exploratory section. I also think the presentation of the results should be improved. Other than that, the data and design can answer the research question, and only minor changes were made to the text, all clearly explained. The conclusions are consistent with the results. So i do not have any concern about the RR aspect, only comments and suggestions about the reporting.

I would like to thank Dr Rousselet on reviewing both stages of this report and for the helpful comments. As an early career research, this input has been invaluable and has improved my research skills and my thesis substantially.

Main points to address

Page 12: “normally distributed” / “assume that normality” – the ridgeplot cannot demonstrate normality, it can only suggest symmetry. By definition, SPNs cannot be normally distributed, as the tails cannot extend to infinity. Many symmetric distributions could give rise to the plot in Figure 4A. In this paragraph the conclusion should be about plausible symmetry and normality should be presented as a reasonable approximation only.

We have changed this section as recommended:

“The ridgeplot in Figure 4A shows that individual participant SPNs are often symmetrically distributed around the mean. While the SPN cannot be normally distributed because the tails cannot extend to infinity, SPN distributions approximate normal distributions.”

We trust that parametric tests are valid with SPN data, even though tails cannot extend to infinity. There are biophysical limits to ERP amplitude, but wouldn't there be similar limits to almost all DVs?

Page 20: the behavioural results should be illustrated using scatterplots to reveal distributions of individual effects. Paired observations should be linked and ideally distributions of pairwise differences should be provided. I have highlighted the importance of such detailed graphical representations in this short editorial for instance: <https://onlinelibrary.wiley.com/doi/10.1111/ejn.13400>

We thank the reviewer for this great resource, we have now followed this and provide figures of the behavioural results in new Figure 8.

Figure 8 could be improved by adding the time-course of the difference to each plot showing two conditions. This will help put the difference in context, relative to the ERP components. Currently the plots are equivalent to bar graphs without error bars. In the right column, it is good practice to add confidence intervals. Another figure is also needed to better illustrate the differences: in a new 3 column figure, I strongly

recommend to show the individual differences for each of the three contrasts, with the average superimposed.

What was Figure 8 is now Figure 9. We have updated Figure 9 with time course of the difference to the ERP plots in the left and central columns.

CI ribbons and individual waves are hard to see when there are multiple difference waves in one plot, as in Figure 9 right column. We have therefore added a new Figure 10, with one column for each difference wave. The new Figure 10 shows CI ribbon and individual difference waves. The new Figure 10 uses the same colour conventions as Figure 9 to aid comparison.

Figure 9: given that the goal is to illustrate the topographies, contrast should be increased. The relative values can be assessed separately in Figure 8. I would replace the confusing GFP with the straightforward STD.

The topographies are now Figure 11.. We have increased the colour contrast by changing the colour scale, and replaced GFP with SD. We have also improved this figure by labelling the electrodes used in statistical analysis.

We have also changed the colours used in Figure 1 for consistency.

Figures 10 and 11 provide outdated and unacceptable graphical representations of the results. Bar graphs hide data and distort perception. Instead, scatterplots of individual measurements should be reported, with linked pairwise observations. Marginal means can easily be superimposed, by plotting short horizontal lines for instance. Confidence intervals could be added too. The system of little stars is confusing, as it suggests that p values measure the importance or strength of an effect, which they obviously do not. You could use one star to indicate significance at the pre-registered threshold.

We agree the simple mean-only bar graphs are outdated. The key advantage of using the mean-only bar graph in the original results Figure 10 (now Figure 12) was that we could

compare the predicted and observed results with the same graphical conventions. The predicted results were already shown in Figure 3 in the introduction. We have confidence intervals in the observed results.

We would like to keep this bar graph as Figure 12. Different analyses use different alpha levels, so we have removed the stars. The 95% confidence intervals already show that all means are significantly < 0 at the conventional 0.05 level.

Most importantly, we have removed the bar graph that was originally Figure 11. We have added a new Figure 13, which illustrates all individual data points, and distribution of 6 possible pairwise differences. The conventions here are the same as those used to illustrate behavioural results in Figure 8.

In the text, and matching the revised graphical representations, it would be very informative to report the number of participants showing effects in the same direction as the group.

We considered reporting this in the text, however this involves a very long paragraph with a long a list proportions. We decided it was more effective to add these proportions under the each distribution in new Figure 13.

Page 24: “There was no difference... $p = .729$ ” – this should be rephrased to avoid this classic statistical fallacy. Here are suggestions on how to report frequentist statistics: <https://discourse.datamethods.org/t/language-for-communicating-frequentist-results-about-treatment-effects/934>

We have change ‘there was no difference’ to ‘there was no significant difference’.

We took care to avoid this classic statistical fallacy by checking whether the effects were significantly less than our a priori definition of a meaningful ERP effect (0.35 microvolts). The original plan was to use this tool confirm the absence perspective cost in the Moving frame block as predicted by Hypothesis 4. However, the same tool can be used to confirm the absence of the expected pairwise differences listed under Hypothesis 3. We have now expanded the exploratory analysis section to cover all pairwise differences.

“Next, we applied the equivalence testing approach to confirm the absence of the four expected pairwise differences listed under Hypothesis 3. These pairwise differences were all significantly less than 0.35 microvolts (Baseline vs Monocular, $t(119) = 2.76$, $p = .003$, $d_z = 0.252$; Baseline vs. Static frame, $t(119) = 2.13$, $p = .018$, $d_z = 0.194$; Baseline vs. Moving Frame, $t(119) = 1.97$, $p = .025$, $d_z = 0.180$; Static frame vs. Moving frame, $t(119) = 2.30$, $p = .012$, $d_z = 0.209$).

Figure 13 shows the two pairwise differences which did not feature in our pre-registered predictions, namely, Monocular vs. Static Frame and Monocular vs. Moving frame. These differences were not significantly different to 0 (Monocular vs. Static Frame $t(119) = -0.77$, $p = 0.445$, $d_z = -0.07$; Monocular vs. Moving Frame, $t(119) = -0.906$, $p = 0.367$, $d_z = -0.083$) but neither were they significantly less than less than 0.35 microvolts (Monocular vs. Static Frame $t(119) = 1.462$, $p = 0.073$, $d_z = 0.133$; Monocular vs. Moving Frame, $t(119) = 1.383$, $p = 0.085$, $d_z = 0.126$).”

In the section on exploratory analyses, my preference would be to report mostly detailed graphical representations, and to remove inferential tests. P values are only interpretable in a narrow preregistered context, unless you can run simulations to derive sampling distributions for your exploratory analyses.

We understand the reviewer's comment. However, the recommender suggests we should include the inferential statistics for exploratory analyses as their weakness is clear since they are under the exploratory section.

Correlation analyses: correlations are very noisy, and in that context it is important to report the minimum correlation you could detect, in the long run, given your sample size. It is also essential to illustrate some of these correlations – see Anscombe's quartet: https://en.wikipedia.org/wiki/Anscombe's_quartet

The estimator is an important choice that must be justified. The default is to use Pearson, which is maximally sensitive to linear relationships, but is also sensitive to other features of the data than an association (outliers, heteroscedasticity, range restriction...). As such, a significant Pearson correlation cannot be used to conclude that there is association.

We have now changed our section on exploratory correlation analysis and included the point about power. Furthermore, we have now used Spearman's Rho as an estimator to avoid potential problems with Pearson's r . We have also included a scatterplot in the supplementary materials help visualize where there is a linear relationship. The correlation matrix is now Figure 14. We describe this as follows:

“Finally, we explored correlations between individual SPN amplitudes, perspective cost, and behavioural performance. The Spearman's rho correlation matrix is shown in Figure 14. We used Spearman's Rho due to non-normal distribution of residuals, although a very similar matrix obtains when Pearson's r was used instead. With our sample of 120, we can expect to detect many moderate correlations (e.g. $r = 0.25$ or $\rho = 0.26$, power = 0.8, $\alpha = 0.05$, two-tailed). Scatterplots associated with this heatmap are shown in Supplementary materials. Participants who had a large SPN in one condition tended to have a larger SPN in the other conditions (red cells in top left, Figure 14A). Unsurprisingly, participants who had a larger frontoparallel SPN tend to have a larger perspective cost, while those with a larger perspective SPN tended to have a smaller

perspective cost (alternating red and blue steps near diagonal, Figure 14B). There was little evidence that perspective cost correlated between blocks (Figure 14C). Those who performed well in one block tended to do so on other blocks (Figure 14D). However, there was little correlation between behavioural performance and ERP signals (just 1/48 significant effects, $\rho = 0.186$, $p = .042$, uncorrected for multiple comparisons, Figure 14E).

Typos & minor comments

Page 10: “with mean amplitude is on the X axis” – delete “is”

Fixed.

Page 12: “in given a block” -> in a given block

Fixed.

Page 14: “Similar stimuli have previously been found TO generate large SPNs” – TO is missing, or use “been associated with large SPNs”. “Makin et al. (2024), which found” – I suggest using reported instead of found, to avoid the awkward “paper... found”.

Changed.

Page 17: “were informed that THE task” – the missing

Fixed.

Page 19: “across time windows” – would be clearer as “time points”, as this paragraph starts by defining one time window. “ERPs were computed from electrode cluster” -> “ERPs were computed from two electrode clusters: ...”

Fixed.

Page 20: extra “obtain” at top of page.

Fixed.

“Prior to analysis of the ERP data...” – this sentence is unfinished.

Fixed.

Discussion:

The two sentences that start with “People could” and “Optic invariants” read as fragments.

This paragraph covered some important considerations about optic invariants, but it perhaps requires elaboration. To focus the discussion on the pre-registered results, we have removed it. We have also clarified the next paragraph:

“Reflectional symmetry is not the only regular arrangement that generates and SPNs (Rampone & Makin, 2020; Martinovic et al., 2011). If one considers our perspective stimuli as 2D images only, the ‘symmetrical’ ones were still more regular than the asymmetrical ones. The ‘symmetrical’ stimuli contained long implicit lines, with some fanning out from a single point and others almost vertical and parallel (Figure 5). Can we be sure that this 2D fan-and-vertical line regularity alone did not account for the SPN in the so-called ‘perspective’ conditions? It is possible that the 2D regularity in the ‘perspective’ conditions was less salient than the 2D reflectional symmetry frontoparallel conditions. This salience difference could explain the observed ‘perspective cost.’ However, we think this explanation is unlikely. As noted in the supplementary materials, participants spontaneously perceived the 3D perceptual interpretation of the stimuli.

“indicated that” / “indicates that” – use “suggests” in second one to avoid repetition.

Fixed.

“internal visual representationS” – s missing.

Fixed.

The paragraphs starting with “The SPN is not specific” and Makin et al. (2015) need better transitions.

We have now changed the starting sentences of each paragraph. Please see manuscript.

Two side-by-side sentences start with “Some implicit lines”

Fixed.

“The participants experienced the 3D interpretation of the stimuli.” -> “Participants experienced 3D interpretations of the stimuli.” – other phrasing suggests they all experience the same interpretation. Maybe I’m over-thinking it.

Fixed.

“there is another explanation FOR this SPN equivalence” – FOR is missing

Fixed.

“did not find zero perspective cost during regularity” – maybe avoid double negative?

Fixed.

“on THE open science framework” – THE missing

Fixed.