Dear Professor Koelewijn,

We sincerely appreciate the time and effort you and the reviewers have dedicated to our manuscript. Below, in red font, you will find our point-by-point responses to each of the reviewer's comments (the locations of the changes in the attached manuscript and supplementary materials are marked in bold). Additionally, we have highlighted all modifications in red font within the attached documents.

On behalf of all authors,

Denis Barbusse

Reviewer 1

The authors have addressed all the points raised by the review.

One optional recommendation for the authors: I understand that the legend of figure 2 explains the color/arrow information, but I'd still recommend adding a text label (good for the figure to stand on its own at a glance, particularly if you want to show it in presentations in the future). But as I mention this is a stylistic preference that the authors can consider to be optional.

Figure 2: We thank the reviewer for the suggestions. We corrected the manuscript accordingly.

Reviewer 2

I'm a bit 'puzzled' by the reply of the authors regarding statistical analyses

Rechecking the normalities with the Shapiro-Wilk test revealed that normality was not confirmed for 9 out of 36 variables. However, since all the normalities were verified with KS tests and a qualitative observation of the data did not reveal any aberrant distributions, we preferred to rely on these results in order to carry out parametric tests, the results of which are more robust.

parametric tests certainly have more power, i.e., you're more likely to detect a significant difference when there is one, but they are less 'robust' than non-parametric tests. And I have difficulties to understand the logic of relying on a less reliable test for normality (namely the KS test with small sample sizes) when a more reliable test shows that a fourth of the tests were likely run on non-parametric data.

We also base our decision to use ANOVAs, on a set of articles that have shown their strong capacity for resilience and robustness with data that do not follow a normal distribution (Schmider et al., 2010, DOI : 10.1027/1614-2241/a000016; for review, see

: Glass et al., 1972, DOI : 10.2307/1169991; Harwell et al., 1992, DOI : 10.2307/1165127).

so, are non-parametric tests useless?? If so, why having tested for normality (with the KS test) in the first place??

Finally, we would like to draw attention to the fact that the statistical tests carried out here have only been used to objectify phenomena that are already clearly visible in figures, simply by looking at the graphs in Figure 3. We were not looking for particularly low significance effects.

I guess this part is the most puzzling. Some results seem pretty clear indeed. But following your 'logic', why report so many statistical results (lines 190-227)??

Overall, we strongly believe that the conclusions reached in the present manuscript would remain the same with others types of statistics.

Data and proper tests are usually more convincing than 'strong beliefs', though overall I don't doubt your results.

For information, 'highly significant' (line 199) does not mean anything. You set a significance threshold (in your case at .05, line 177), so the test is either significant or non-significant. Also, Bonferroni is not a test (line 176), but a correction method to control the false alarm rate when running multiple comparisons.?

Line 174-182, 191, 194-196, 200-202, 211-212, 216-218, 223-224 and Supplementary Tables S3-5-7: We thank the reviewer for her/his rigorous expertise of our work. For all variables not respecting normality, we repeated the analyses using Sheirer-Ray-Hare tests, a non-parametric tests that is recommended for the analysis of repeated measures with several factors (Conover, W. J.,1999).

This change had little impact on our results. Between blocks differences on Movement Duration is no-longer significant, nor is the interaction Body orientation x Block (Supplementary Table S5). Block and Body Orientation x Block differences in Elbow Contribution to the total amplitude no-longer reach significance either (Table S3). Between blocks differences on Number of Movements is no-longer significant (Supplementary Table S5). These results do not change the main conclusion of the study, they only impact the fine description of the general characteristics of the movements we studied in here (lines 191 and Supplementary Tables S3-5).

More importantly, the change to the non-parametric test had some impact on the statistics of our main variables (those describing the temporal organisation of the movements). It removed a simple effect of the Block factor on ΔRtPV and ΔRtPD (lines 200-202, 216-218 and Supplementary Tables S7). This does not impact our main conclusion, as it is based on the interaction between Body orientation and Block, whose effect remains significant.

Reviewer 3

Main concern but easily fixed:

Lines 248-249 I am confused on why authors did not include their new analyses about movement body-orientation and amplitude here. It explains what people did when first introduced to the uncommon/less common body-orientation, which involve spatial-temporal reorganization, which would be part of the re-optimisation process. It also might imply that if emphasis was placed on maintaining a set spatial amplitude, re-optimisation for Head-Down would likely be the same as Head-Up. However, that still requires study. And it is this latter issue that should be mentioned in the limitation section on Lines 309-319.

We thank the reviewer for her/his comment. We did not discuss the results of this spatial analysis in the paragraph mentioned by the reviewer because this paragraph is dedicated to discussing movement optimality in the gravity field. Using both experimental and theoretical approaches (i.e., optimal control models), the literature on this aspect has focused on the temporal organization of arm movements. We therefore discuss those results here. To the best of our knowledge, no study has modelled arm movement endpoint errors (overshoot, undershoot) to demonstrate that end-pojnt over/under-shoot reflects an optimal solution in the gravity environment. Thus, to avoid too much speculative discussions in this first paragraph, we kept those results out of it. Nonetheless, we agree that the spatial organisation of arm movements may also reflect motor optimization in the gravity field. Future studies may specifically test this. We added a few lines in the limits section to better acknowledge this point (please see lines 321-324).

Minor items:

Line 36: I don't understand "would first". I think authors meant just "feedforward ones remain unmodified."

Line 36: We thank the reviewer for spotting this error. We corrected the manuscript accordingly.

As mentioned previously, this is an editorial preference, but I do not care for the use inanimate objects doing things. Consider changing "The present study aims…" to "In the present study, we aim…" on Line 111 and "…, the literature has…" to "…, researchers have …" on line 265.

Line 111 and 267: We appreciate the reviewer's suggestions and have revised the manuscript accordingly.

Line 153: it would be great to have authors list a reference for the use of 10% of max velocity. Others have used 5% or a specific velocity threshold.

Line 154: We added two references for the use of 10% threshold as suggested by the reviewer.

Lines 170-172: Needs a reference here, especially considering authors mention specific variables.

Line 172-173: We thank the reviewer for the valuable suggestions and have updated the manuscript accordingly.

Results in general--I find it odd that authors present the main effects after the interactions. I have always seen main effects, followed by interactions. Consider changing this order.

We prefer to report the effect of interaction first, for two reasons. 1. This is the main result and our conclusions are mostly based on it. 2. Interaction effects may hide simple effects. This is for example what happens to the block effect on the temporal organization of arm movement. Reporting the block effect first would orientate the reader towards an ambiguous interpretation/conclusion. We thank the reviewer for this suggestion.

Line 185-6: stats show only less movement in the first than 4-6, not blocks 2 and 3. Re-word for accuracy. Please check all stats and corresponding text, as there is so much going on, it is easy to miss.

Line 186-191 and Supplemental Table S5: We thank the reviewer for the spotting this error. These results lightly change with non-parametric analyses recommended by the reviewer 2 and the error was corrected accordingly.

Figure 3: Why is there a "ns" for 3 and 6 for C but not 3-5? Why is there a "ns" for 2 and 6 for E but not 3-5? The graphs are more confusing with "ns". I don't believe these are needed, so I would remove all and adjust the caption. Lines 206-209. Is there a way to include the results from one-sample t tests on the Figure?

Figure 3: We thank the reviewer for the suggestions. We have removed the 'ns' and '***' for condition differences in blocks 1, 3, 4 and 6 for clarity. To keep the figure simple and light, we think it would be better to not include the results of the T-tests in the figure.

Line 256: The word "first" seems odd here. If removed, it doesn't alter the content, so I would remove it.

Line 258: We thank the reviewer for the suggestions. We corrected the manuscript accordingly.

Supplementary file, Figure S2: the last word should be singular, thus "participant" rather than "participants"

Supplementary Figure S2: We appreciate the reviewer's insightful suggestion and have adjusted the manuscript in response.

Lines 296-7: "Stating that the values were first reversed, compared to Head-Up baseline, and then adapted back to values that were close to Head-Up baseline ones." is misleading. It sounds like you mean there is a significant difference between Head-Up and Head-Down at block 4 before achieving ns at block 5 and 6 again. Results showed no significant differences at these blocks. Re-word for clarity please.

Line 300: We thank the reviewer for the suggestions. We corrected the manuscript accordingly.