

Manuscript entitled "Designing Virtual Spaces to Support Collaborative Creativity."

The first revision

Response to Reviewers

12 August 2019

We really appreciate the reviews we received which will certainly help to improve our manuscript. We have addressed the points raised by the reviewers and would like to explain these changes below. The reviewers' comments are in bold text and our responses are in plain text.

Response to Reviewer 1's Comments

The experimental design section ... no specific information is given on the subjects' background, age, recruitment process.

We have added additional information at the beginning of the experiment section. Specifically, the added information includes: the recruitment process (emailing group lists with the authors' school), participants' musical knowledge, computer skills, and the experience of using groupware and VR.

Information on the experimental hardware setup should be provided: what VR headset was used, how was the tracking of the user position done, how were the hands tracked (input device).

This information has been extended in the section "LeMo - An SVE for collaborative music making", see lines 184 - 187, and an in-text reference has been added when explaining the experimental procedure in line 324.

Captions for Figures should provide additional information on what results are presented.

Additional information has been added to the captions of these figures: Figure 4 has been remade, and in-picture captions have been added to explain the features of each condition; for Figure 5 & 6, the value of N (number of measurements) has been added; Figure 7's caption has been extended to better explain the visual elements of the figure.

Figure 4, it's not fully clear how this was presented to the users. Could there be examples added for each what the users saw?

Figure 4 has been remade, a first-person perspective showing all the elements in the virtual experimental scene and four third-person perspectives showing the four experimental conditions have been included. Third-person perspectives might make it easier to differentiate the difference between conditions.

Figures 5 and 6 should include value of N (number of measurements). The chart labels for questions could perhaps also include the theme of the questions Q1-11, as in Table 2 (in parenthesis next to the question). Why are questions there labeled as CQ1-11 while labels in Figures are Q1-11?

We have revised Figures 5 and 6 following this suggestion. Post-Session Questions (PSQ) in Table 1 are the questions shown in Figures 5 and 6, CQ (comparison questions) are another set of questions, asking participants to compare conditions at the very end of the experiment.

Figure 7, caption should explain what the labels mean; location (shown as dots), direction (shown as arrows), etc. Why was this particular group selected?

We have extended the caption to include the explanation. Group 3 was not chosen for any specific reason, the aim of Figure 7 is to show the visual trace in greater detail, so any group could have been

chosen. It also helps the reader make sense of Figure 8 (in which visual traces are much smaller). A brief explanation has been added in the text (in line 470-473), where Figure 7 is first mentioned.

Figure 8 needs more explanation. Is this top view? How was it measured?

We have extended the caption by explaining that these visual traces are top-view of visualised participants' locations, directions and musical note edits, and they are made based on system-logged data, including positions and rotations of participants' heads, and interactions with music interfaces, an in-text reference has also been added (471-473), referring data-log system to the sub-section "LeMo - An SVE for Collaborative Music Making", which explains how the data was gathered. The data-log system's explanation has been modified to be more detailed in line 207-211, e.g. the devices being used have been added.

Page 13, last paragraph.. "The redder/bluer..." should be rephrased to refer to the color intensity.

This sentence has been rephrased to "The more intensely blue or red the area is, the more presence the corresponding participant had shown in that location."

Response to Reviewer 2's Comments

Lines 102-104 need more clarification as to how the authors addressed the concern in their project, and how it differs (or not) from this study. Additional context would help here.

In lines 100-107, we have added more information about their projects and why their studies differ from ours: their study was performed based on 2D-screen media, which made their findings less informative for 3D media including VR.

Line 106, define 'tabletop'.

In lines 116-119, relevant references (such as Kruger et al., 2004, and Scott et al., 2004) have been added to define the term 'tabletop'.

Lines 171-172, address how the new system differs from the old one, and briefly why the changes were made. The authors also note that Figure 2 is from the other 2019 study, which is confusing to readers since it was stated that the new system is very different. Did the interface not change?

This study and the 2019 study are actually using the same, newer, LeMo system (2019), which was developed on the basis of the old LeMo system (2018). In lines 177-182, we have corrected the citation to make this point clearer. The old 2018 LeMo has a different interface, however, that study is not part of this paper except for introducing the system development history.

The results section could use clarifications. Please review and clarify the language in lines 350-414.

We have reviewed and clarified these paragraphs.

Figures 6 and 7 have corresponding colors to indicate conditions, but the distinction is not strong on black/white printouts. Please make it more clear without using color which condition is which.

We assume Reviewer 2 meant Figures 5 and 6 and so have strengthened the texture patterns in the bar charts (e.g. the dotted pattern has become thicker now, and grid pattern has been introduced).

We retained the colour hue because we believe this feature will ease the reading for people with normal vision without introducing any difficulties for people with visual impairments given the stronger patterns used.

Line 464: What is Cpi? I think this is a typo.

This is a typo, and it has been corrected.

Experimental design

There were multiple areas where what appeared to be research questions were stated (lines 46-47 and 76-78). Please clarify which set of questions you sought to answer and ensure that they are the same question if repeated elsewhere in the paper.

The discussion related back to the results of this study and tied in with the results of the author's previous study of the same system. It would be helpful if the authors restated their research questions at the beginning of the discussion, and used them as references for the structure of the discussion.

We have unified these questions into one overall question: How should Shared Virtual Environments be designed to support creative collaboration? This research question has now been restated at the start of the discussion, and followed by a brief structure of the discussion: "...we will firstly discuss i) the necessity, ii) the impacts of adding each type of personal space, then compare iii) the differences of adding personal space with/without mobility, and iv) personal space with rigid/fluid boundary."

I do have a concern about the Post Session Questionnaire in Table 1. The questions were either phrased positively or neutrally, with no negative statements (e.g. The spatial configuration of this virtual world was difficult for me to understand). Please provide rationale for using positive or neutral phrases in the questionnaire.

We agree that this is a limitation of the study, and we have stated this limitation and discussed the possible impacts of the results (e.g. participants might have given more positive ratings). However, this imperfection has a limited influence on this study, because PSQ results are mostly used for comparisons between conditions, which are affected equally by this imperfection due to all of the conditions using the same phrasing.

The participant quotations brought the statistical findings to life and provided a deeper level of analysis to the themes that arose out of the questionnaire. Removal of the LeMo feedback (lines 618-621) kept the paper in focus.

This section has been removed.

There are minor grammatical errors in the Discussion section. I recommend a grammar check to rectify these errors.

The discussion section has been proofread and grammatical errors have been corrected.

References:

Kruger, R., Carpendale, S., Scott, S.D. and Greenberg, S., 2004. Roles of orientation in tabletop collaboration: Comprehension, coordination and communication. *Computer Supported Cooperative Work (CSCW)*, 13(5-6), pp.501-537.

Scott, S.D., Carpendale, M.S.T. and Inkpen, K.M., 2004, November. Territoriality in collaborative tabletop workspaces. In Proceedings of the 2004 ACM conference on Computer supported cooperative work (pp. 294-303). ACM.