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As the title suggests, [0] strongly criticizes the use of post questionnaires as a mean to measure presence in virtual reality experiments. The author argues that such questionnaires cannot guarantee that the reported presence was not an effect evoked by the simple fact of being asked about.

To illustrate the problem, the author creates the arbitrary concept of “colorfulness”, and measures how much colorful the day of yesterday was for 74 subjects through a questionnaire. Given that answers to related questions did not clustered around the middle of the scale, but instead were significantly different from that, the author argues that subjects attributed significance to that concept. We do not have a definition of what a colorful day is, yet we know that waking up late and accomplishing tasks increases our chance of having one.

As for the colorfulness of a day, the author argues that we have no real evidence that the phenomena of presence exists. It is stated that presence cannot be evaluated in a reliable way as it does not manifest itself as a measurable phenomenon through user behavior or a mental state (as long as the state of the art of research on presence is concerned). However, as researchers we may know that presence exists through introspection regarding our own state while immersed in a virtual environment (VE), but the subject may attribute his own arbitrary meaning when confronted with such concept in a post experiment questionnaire.

The author makes the point that there are less subjective ways of measuring presence [1, 2], yet it seems questionnaires are always preferred, probably for being easier to apply. Finally, the author does not rule out the importance of questionnaires for research in presence, but argues that it is a tool more suitable for hypothesis generation than hypothesis testing.

Although most references relates to the conceptualization of presence, [1, 2] approach less subjective means of measuring presence through behavior or physiological responses, while [3, 4] present previous critiques to the measurement of presence through questionnaires.

More specifically, [1] uses physiological measurements to assess presence under the stressful situation of standing at the edge of a virtual precipice. This assumes that an increased sense of presence towards the VE is expected to evoke similar behavior and physiological reaction as the same experience would provoke if real. Additionally, [2] asks subject to report when they had a Break in Presence (BIP), i.e. when they became aware of the real environment they are in.

In [3], a group of subjects performed a task in a real environment, while a second group performed the same task in a VE equipped with immersive virtual reality equipment. Surprisingly, no significant difference on reported presence was found between the groups with questionnaires. Moreover, in [4] the authors demonstrate how prior experience could interfere on the subjective rating of presence.

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This paper was cited 272 times according to Google scholar on June 14th 2019. The most recognized of these papers is [5] in 2005, which provides an overview of the state of the art of research on presence, and suggests a link with research on neuroscience. This paper explicitly recalls the issues induced by measuring presence through questionnaires and briefly discusses some behavioral alternatives (e.g. induced body movement).

On the contrary, a more recent meta-analysis from 2016 [6] computes the power of immersive features for eliciting presence by considering only prior studies relying on self-reports. Their authors argue that body movements (e.g. leaning), physiological arousal and memory tests may carry some ambiguity in reporting spatial presence.

Beyond these two review papers, most other papers often cite [0] as a means to define presence (i.e. ignoring the main core of the discussion), or to justify the usage of measurements that does not consist solely of questionnaires. There are also papers that further develop the concept of presence and propose new means of measurement; even though these are not among the most cited, they are the most interesting for this discussion.

Although there is (still) no generalizable approach to objectively measure presence, physiological measurements seem to be among the preferred means. However, such class of measurement is application specific and cannot address presence for all kinds of situations one may experience. Different experiences are expected to give rise to distinct behaviors, requiring adaptation of the measuring method. Therefore, effort to relate distinct means of measuring presence was made such as [7] in 2003¹ that relates physiological measurements with Break in Presence (BIP) count.

Finally, Baus and Bouchard [8] advocate in 2017 for integrating the presence questions *during* the immersion time. However, they stress the critical importance to reduce the number of questions to a single one to alleviate the risks of Break in Presence. This *immersive* strategy is actually quite feasible with an HMD as it is possible for the subject to quickly answer a few questions by guiding a pointer with the gazing direction and fixing the desired answer during a predefined duration for validating it.

Conclusion

I expect that dismantling the concept of presence into components that can be measured more directly will allow the creation of a model to estimate presence beforehand, which may be based on equipment, VE and subject attributes and background. Moreover, the discussion on presence seems to be shifting into the broader field of cognitive neuroscience, in which one's virtual body representation is added to the equation [9]. This raises questions regarding the relation we may develop with our virtual body (sense of embodiment) as well as with the VE (sense of presence).

¹ See the reference page note about the publication year

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Note:

Even though [7] has been published before [0], it cites [0]. Both papers have Mel Slater as author, thus I conclude that [0] had to wait a long period between acceptance and publication.