

1 **Examining the impact of experiencing auditory verbal hallucinations from a first-person**  
2 **perspective on the degree of empathy and stigmatization in a group of psychology students: A**  
3 **study using 360° immersive videos**

4 **Running short title: The impact of simulation on empathy and stigma**

5 C. Della Libera<sup>a\*</sup>, M. Goosse<sup>a\*</sup>, F. Larøi<sup>ab\*\*</sup>, S. Willems<sup>a\*\*</sup>

6 *\*These authors declare to share the first authorship.*

7 *\*\* These authors declare to share the last authorship*

8 *<sup>a</sup> Psychology and Neuroscience of Cognition Research Unit, University of Liège, Liège, Belgium.*

9 *<sup>b</sup> Department of Psychology, University of Oslo, Oslo, Norway.*

10  
11 **ABSTRACT**

12 *Background:* Stigmatization toward psychosis is persistent among mental health professionals (MHPs)  
13 and negatively impacts the patients' outcomes. One suggested way of reducing stigmatization is to  
14 expose MHPs to simulations of psychotic symptoms. This approach has been associated with an  
15 increase in empathy, but also with an increase in the desire of social distance. The addition of an  
16 empathic task (ET) has been suggested to neutralize this effect on social distance. The present study  
17 aims to (1) examine the effect of a remotely administered 360° immersive video (360IV) simulation  
18 on empathy and stigma among psychology students and (2) replicate the neutralizing effect of an ET  
19 on social distance. Finally, the potential role of immersive properties on changes will also be explored.

20 *Methods:* A 360IV simulating auditory hallucinations was constructed in collaboration with patient  
21 partners. 121 psychology students were allocated to one of three conditions: (i) exposure to the 360IV,  
22 (ii) exposure to the 360IV and to an ET (360IV + ET), and (iii) no exposure (control). Measures of  
23 empathy and stigma (stereotypes and social distance) were collected before and after the interventions.

24 *Results:* An increase of empathy was observed in the 360IV and 360IV + ET conditions compared to  
25 the control condition. There was an increase of stereotypes in all conditions and no effect on social  
26 distance.

27 *Conclusions:* This study confirms the effectiveness of a 360IV simulation intervention in increasing  
28 empathy in psychology students but questions its efficacy in reducing stigma.

29  
30 *Keywords:* Psychotic disorders; Stereotyping; empathy; 360-degree immersive videos

31 **Corresponding author:** Frank Larøi; frank.laroi@psykologi.uio.no; Department of Psychology

32 University of Oslo, Postboks 1094, Blindern, 0317 OSLO, Norway

33  
34 **Acknowledgments:** We thank Yasmin Shekry, Aurélie Wagener, Jessica Simon, Jean Paul Noel, and  
35 Lucie Soumoy, who helped create the 360° immersive video. The research was funded by the

1 University of Liège – Social Sciences and Humanities Research Fund. Clara Della Libera is funded by  
2 the University of Liège with the “Bourse de doctorat en sciences humaines.” Manon Goosse is funded  
3 by a Humanities PDR grant from the University of Liège.

4 **Conflict interest statement:** The authors do not have any conflict of interest to disclose.

5

6

1 **Examining the impact of experiencing auditory verbal hallucinations from a first-person**  
2 **perspective on the degree of empathy and stigmatization in a group of psychology students:**  
3 **A study using 360° immersive videos**

4 **ABSTRACT**

5 *Background:* Stigmatization toward psychosis is persistent among mental health professionals (MHPs)  
6 and negatively impacts the patients' outcomes. One suggested way of reducing stigmatization is to  
7 expose MHPs to simulations of psychotic symptoms. This approach has been associated with an  
8 increase in empathy, but also with an increase in the desire of social distance. The addition of an  
9 empathic task (ET) has been suggested to neutralize this effect on social distance. The present study  
10 aims to (1) examine the effect of a remotely administered 360° immersive video (360IV) simulation  
11 on empathy and stigma among psychology students and (2) replicate the neutralizing effect of an ET  
12 on social distance. Finally, the potential role of immersive properties on changes will also be explored.

13 *Methods:* A 360IV simulating auditory hallucinations was constructed in collaboration with patient  
14 partners. 121 psychology students were allocated to one of three conditions: (i) exposure to the 360IV,  
15 (ii) exposure to the 360IV and to an ET (360IV + ET), and (iii) no exposure (control). Measures of  
16 empathy and stigma (stereotypes and social distance) were collected before and after the interventions.

17 *Results:* An increase of empathy was observed in the 360IV and 360IV + ET conditions compared to  
18 the control condition. There was an increase of stereotypes in all conditions and no effect on social  
19 distance.

20 *Conclusions:* This study confirms the effectiveness of a 360IV simulation intervention in increasing  
21 empathy in psychology students but questions its efficacy in reducing stigma.

22  
23  
24 **Keywords:** Psychotic disorders; stereotyping; empathy; 360-degree immersive videos

## 1 1. Introduction

2

3           Psychosis is one of the most stigmatized mental illness by not only the general population [1],  
4 but also mental health professionals (MHPs) [2] and future professionals, such as students [3].  
5 Persistent stigma may include negative attitudes such as a desire for social distance and stereotypical  
6 beliefs related to poor prognosis, dangerousness, and incompetency [2]. Such stigma may negatively  
7 impact patient outcomes via two main routes. First, negative attitudes among MHPs may lead to  
8 negative behaviors such as authoritarianism (the MHP making decisions instead of the patient),  
9 overmedication, or coercive treatment [4]. Second, patient exposure to stigma may result in them  
10 internalizing the stigma, where patients begin to agree with stigmatizing attitudes and begin to apply  
11 them [5]. This so-called self-stigmatization process can directly affect the severity of psychosis  
12 through its impact on self-esteem, isolation, distress, and appraisal of symptoms [6,7]. These negative  
13 impacts of MHPs' stigma toward patients highlight the importance of developing effective ways of  
14 reducing stigmatization among MHPs and future MHPs such as students. This study focuses on  
15 psychology students, who will most likely have very frequent exposure to people with mental illness.

16           One strategy that has been used for years is simulation intervention (SI), which consists of  
17 exposing individuals to a reproduction of a stigmatized clinical symptom. The basis of SI is that  
18 allowing an individual to take the perspective of a member of a stigmatized group may promote  
19 empathy and result in individuals revising their own negative beliefs and attitudes [8]. Moreover,  
20 empathy is generally associated with positive attitudes [9]. In the specific context of psychotic  
21 symptoms, SI has been essentially used for auditory verbal hallucinations (AVHs). A well-known  
22 example is Deegan's "Hearing voices that are distressing" soundtrack, which exposes participants  
23 from the general population or future MHPs to distressing AVH via earphones while performing  
24 another task (e.g., taking a walk on campus).

25           Based on systematic reviews and meta-analyses [10,11], the few studies that have examined  
26 the effect of this auditory SI have shown mixed results on empathy. One study reported a small effect  
27 size among medical students as participants ( $d = 0.34^1$ ) [12]. In another study, there was no effect  
28 [13]<sup>2</sup>. Results for negative attitudes showed either no effect [13] or even a strong increase in desire for  
29 social distance among a sample of students ( $d = 0.90$ ) [14]. Taken together, these studies suggest that  
30 auditory SI can sometimes be effective in increasing empathy but can also have detrimental effects,  
31 such as increasing a desire for social distance. In addition, few studies have specifically targeted

---

<sup>1</sup> Cohen (1992) [60] suggested that  $d = 0.2$  should be considered as a small effect size, while  $d = 0.5$  represents a medium effect size, and  $d = 0.8$  represents a large effect size.

<sup>2</sup> The type of sample included in this study was not reported.

1 psychology students.

2           The recent introduction of immersive technologies may lead to new perspectives toward SI in  
3 the field of destigmatization. Immersive technologies include virtual reality (VR), which involves  
4 interacting in a 3D computer-generated environment. Another immersive technology is 360-degree  
5 videos (360IVs), which involve visually exploring a pre-recorded 360-degree scenario (see Kittel et al.  
6 [15] for a detailed comparison of both technologies). In contrast to a simple auditory SI, immersive  
7 technologies have the advantage of providing a multisensory coordinated stimulation including  
8 hearing, vision, and in the case of VR, proprioception. Therefore, immersive technologies allow  
9 individuals to take the perspective of a member of a stigmatized group and thus may trigger empathic  
10 responses toward this group [16,17].

11           Currently, only two studies [18,19] have examined the effects of an immersive AVH SI. Both  
12 studies used a VR system and examined its effect on a sample of psychology students. The first study  
13 [18] utilized a non-controlled pre- and post-test design with SI alone as the intervention, while the  
14 second study [19] utilized a randomized controlled design with four conditions. The four conditions  
15 consisted of (1) SI, (2) SI plus an empathic task (ET) (2 minutes of writing down one's thoughts about  
16 how it is to live with the symptoms), (3) an ET only, and (4) nothing (control condition). Firstly, both  
17 studies confirmed the positive effect of SI on empathy. In particular, Formosa et al. [18] reported a  
18 large ( $d = 2.57$ ) and significant increase of empathy after the SI in comparison to the pre-intervention.  
19 Similarly, Kaylanaraman et al. [19] reported a large main effect of a condition ( $\omega^2 = 0.21$ )<sup>3</sup> with a  
20 larger effect in all conditions including SI. Moreover, mixed results were found regarding stigma. In  
21 the first study, results indicated a positive and medium size effect ( $d = 0.69$ ) of SI [18]. However, the  
22 measure of attitudes was broad and included items similar to the desire for social distance (e.g., "I  
23 would not want to live next door to someone who has a diagnosis of schizophrenia").

24           In contrast, the second study used distinct measures of attitudes and desire for social distance  
25 [19] and found a positive and medium size main effect ( $\omega^2 = 0.11$ ) on attitudes but a negative and  
26 medium main effect size ( $\omega^2 = 0.11$ ) on the desire for social distance. However, this negative effect  
27 was cancelled with the addition of the ET. Taken together, these results are in line with one study that  
28 used a non-immersive auditory SI in regard to their potential positive effects on empathy [12].  
29 However, these results also suggest that SI may potentially elicit a desire for social distance.

30           Despite these potentially interesting findings, using VR remains a costly tool in terms of  
31 material and environment programming. In addition, VR currently requires the participant to be

---

<sup>3</sup> Field [61] suggested that  $\omega^2 = 0.01$  represents a small effect;  $\omega^2 = 0.06$  represents a medium one, and 0.14 represents a large effect size.

1 present in the place where the intervention is implemented. In response to these limitations, an  
2 interesting alternative is the use of 360IV, which is financially accessible and can be developed with  
3 little technical skill. In addition, it can be used outside of the lab or training center since it allows  
4 participants to be exposed at home with a low-cost headset (e.g., Google Cardboard).

5 One important aspect to consider when creating a 360IV concerns its immersive properties.  
6 These include its ability to (1) avoid “cybersickness” (negative physical feelings such as nausea) [20]  
7 and (2) elicit two broad illusions of presence, namely (a) “place presence” (the perceptual illusion of  
8 “being there” in the immersive experience) [21] and (b) “social presence” (the perceptual illusion of  
9 being together with other characters from the immersive environment) [22]. Several studies have  
10 confirmed that 360IV do not elicit high levels of cybersickness [23,24] and are able to elicit both place  
11 (masked for anonymous version) and social presence [25, masked for anonymous version]. These  
12 illusions are considered as necessary conditions for realistic emotional and cognitive reactions [26,27],  
13 and more specifically, social presence has been suggested as a key process for eliciting empathy  
14 toward others [26].

15 Several studies indicate that 360IV increases empathy in different contexts [28,29]. However,  
16 to the best of our knowledge, 360IV has never been used as in SIs. In addition, the changes in empathy  
17 have never been explored in relation to immersive properties particularly the different facets of  
18 presence (presence in place and social presence).

19 The present study examined the effect of a remotely administered 360IV SI might on empathy  
20 and stigma in a group of students in psychology. Three experimental conditions were tested: (1)  
21 immersion in a 360IV simulating voice hearing, (2) immersion in the same 360° video with the  
22 addition of an ET (360IV + ET), and (3) no immersion (control). We hypothesized that there would be  
23 (1) an increase in empathy in the 360IV and 360IV + ET conditions, but not in the control condition,  
24 (2) a decrease in stereotypes in the 360IV and 360IV + ET conditions, but not in the control condition,  
25 and (3) an increase in social distance in the 360IV condition, but not in the 360IV + ET and control  
26 conditions. The effect of the immersive properties on changes in these measures was also explored.

## 28 **2. Methods**

### 30 *2.1. Participants*

1 The study was approved by the local ethics committee of {Masked for anonymous version}.<sup>4</sup>  
2 De-identified data and supplementary materials are publicly available on the Open science Framework  
3 at <https://osf.io/dz7ny/>. Through social networks, 121 students in psychology were recruited from  
4 three universities (the University of Liège, the Catholic University of Louvain-La-Neuve, and the Free  
5 University of Brussels) (Table 1). These universities were selected because they represent all the  
6 French-speaking Universities in Belgium. This number was based on a power analysis performed a  
7 priori with G\*Power 3.1. [30].

8 Following the results of Kalyanaraman et al. [19], whose design was similar to the present  
9 study's design, the expected difference at pre- and post-test in terms of effect size was  $\omega^2 = 0.15$   
10 (power of 0.80,  $\alpha$ -error of 0.05), giving a required number of 111 participants. The study was  
11 presented as an investigation of the effect of knowledge and representations about schizophrenia.  
12 Participants were excluded if they suffered from epilepsy, severe migraine, or motion sickness.  
13 Participants were assigned to one of the three conditions (360IV, 360IV + ET, or control) following a  
14 pseudo-randomization that formed equivalent groups in terms of age, academic level, and gender  
15 proportion. Participants who guessed the purpose of the study were excluded from the analyses.

## 17 2.2. Destigmatizing interventions

### 19 2.2.1. 360IV simulation

21 The 360IV (available here: ) was originally constructed to assess a set of various  
22 psychological processes in a daily-life situation (see details in {Masked for anonymous version} under  
23 review). The 360IV lasts three minutes and 13 seconds and was created with a Vuze + 3D-360 VR  
24 camera (settings: 8K, HD). The IV presents an internal and external area of a coffee shop with 20  
25 actors playing clients and one waitress, who are serving or drinking coffee/alcohol, discussing  
26 between themselves, laughing, smoking, and sometimes interacting with the camera with gazes.  
27 Participants who watch the video with a VR headset can see the scenario as if they were in the  
28 camera's place and seated at a table.

29 A soundtrack imitating hallucinations was added to the 360IV (for details, see supplementary  
30 material, section 1). The soundtrack was constructed in collaboration with two partner patients in order  
31 to ensure a high degree of realism of the hallucinations. Firstly, typical voice characteristics were  
32 extracted from the literature [19, 31] as a basis for discussion with the patient partners. Specifically,  
33 the following seven factors were selected: the voice's gender, clarity (whispering, clear, screaming),

---

<sup>4</sup> Reference: 2021-095

1 and valence (positive, negative or neutral); content (general comments or messages to the participant);  
2 the direction of the voices (directly speaking to the participant or speaking to each other); intensity  
3 (normal, strong, or normal becoming strong); linguistic complexity (simple words or basic phrases);  
4 and the origin of the sound (coming from a particular side). Based on this, the patient partners were  
5 asked to identify the characteristics of their experiences.

6 Several features were reported as important and were emphasized in the scenario: (1) the  
7 valence of the voices (at first, they are positive and then progressively become increasingly negative);  
8 (2) the intensity (whispers); and (3) changes in spatial origin (for example, from the front or the back).  
9 Secondly, a soundtrack composed of two voices that vary in the seven factors was constructed and  
10 inserted onto the 360IV. One of the voices is from a patient who hears voices, and another is from a  
11 woman who was coached by the research team. The voices were recorded with a Roland CS-10EM  
12 Binaural 3D in-ear microphone, which allows the sound to be spatialized. The whole scenario was  
13 then validated by the patient partners.

#### 14 15 2.2.2. *Empathic task* 16

17 The ET was adapted from Kaylanaraman et al. [19] (see supplementary material, section 2).  
18 Although other tasks that trigger empathy exist (for examples of these, see Chirico and Gaggioli [23]),  
19 the same task was chosen to test the replicability of the neutralizing effect of the ET on social distance  
20 observed by these authors. Moreover, this task is easily adapted to remote administration. The task  
21 consisted of taking a minute to imagine and write about how a person suffering from schizophrenia  
22 feels when they go into a bar and hear voices or see things that others do not hear or see.

#### 23 24 2.2.3. *Written description of auditory verbal hallucinations (AVH).* 25

26 Because the students were from different universities and years of study, a description of AVH  
27 was provided to all participants in order to provide a common base of familiarity with psychosis and  
28 AVH. This written description of AVH included: (1) general information about AVH as experienced in  
29 clinical and non-clinical populations and (2) a description of clinical AVH experiences (see  
30 supplementary material, section 3). The general information was based on previous work from Larøi  
31 and colleagues [32], which highlights the role of negative content in differentiating clinical and non-  
32 clinical AVH. The description of clinical AVH experiences is a collection of descriptions given by the  
33 voice-hearing patient partner.



1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35

## 2.3. Measures

### 2.3.1. Empathy

#### 2.3.1.1. Interpersonal reactivity Index (IRI) [33]

In order to ensure the equivalence of the groups in terms of dispositional attitude to empathy, the French version of the IRI [34] was used. The IRI consists of 28 items that assess (1) perspective taking (the tendency to spontaneously adopt the psychological point of view of others); (2) fantasy (the tendency to transpose themselves imaginatively into the feelings and actions of fictitious characters in books, movies, and plays); (3) empathic concerns (other-oriented feelings of sympathy and concern for unfortunate others); and (4) personal distress (self-oriented feelings of personal anxiety and unease in tense, interpersonal settings). Each item is rated on a 5-point Likert scale (ranging from 1 = “Does not describe me at all” to 5 = “Completely describes me”), giving a total summed score ranging from 7 to 35 for each factor. Internal reliability was calculated with McDonald’s omega, which ranged from acceptable to good in the present study ( $\omega^{PT} = 0.68$ ,  $\omega^{IF} = 0.73$ ,  $\omega^{EC} = 0.70$ ,  $\omega^{PD} = 0.68$ ) and was just slightly below the reliability indices in the original study [33].

#### 2.3.1.2. Situational interpersonal reactivity index (SIRI) [28]

In order to assess the impact of the intervention on empathy towards those who hear voices, a situational empathy tool was used. Following Schutte and Stilinović [28], seven items from the IRI [33] that assess dispositional empathy were converted to a specific situational evaluation. The 7 items were divided into two subscales for (1) perspective taking (the tendency to spontaneously adopt the psychological point of view of others; e.g., “I feel like I was in that person’s shoes”) and (2) empathic concerns (other-oriented feelings of sympathy and concern for unfortunate others; e.g., “I felt touched by this person’s situation”). Participants were asked to imagine themselves to be in front of a one who hears voices and to rate the items using a 5-point Likert scale ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). Higher total scores indicate higher levels of situational empathy. For the present study, internal reliability calculated with McDonald’s omega was mainly acceptable (i.e.,  $\omega^{EC-pre} = 0.72$ ;  $\omega^{PT-pre} = 0.63$ ;  $\omega^{EC-post} = 0.79$ ;  $\omega^{EC-post} = 0.70$ ) and was slightly below the good internal reliability indices reported in the original study [28].

1 2.3.2. *Stigma*

2

3 2.3.2.1. *Social Distance Scale (SDS)* [35]

4

5 The Social Distance Scale (SDS) was used to assess the participants' preferences for social  
6 distance from a person with schizophrenia. The SDS is recognized as one of the most widely used  
7 scales in stigma literature [36] and was chosen in order to allow inter-study comparisons. The SDS  
8 consists of seven statements (e.g., "I would not mind having a person with schizophrenia as a  
9 neighbor"), which are evaluated on a 5-point Likert scale ranging from 1 ("strongly agree" to 5  
10 ("strongly disagree"). The total score thus ranges from 7 to 35, with higher scores indicating higher  
11 desire for social distance. For the present study, internal reliability calculated with McDonald's omega  
12 was good ( $\omega^{\text{Pre}} = 0.82$ ; to 0.82;  $\omega^{\text{Post}} = 0.89$ ) and is comparable to that of a previous study [37].

13

14 2.3.2.2. *Stereotypes towards psychosis (STP)* [38]

15

16 The questionnaire was used to assess explicit stereotypes, especially those associated with  
17 people suffering from psychosis. The questionnaire consists of 7 items assessing perceptions about the  
18 following: (1) ability to cope with stress, (2) social background, (3) untreatability, (4) dangerousness,  
19 (5) intelligence, (6) unpredictability, and (7) creativity. Participants are asked to assess if they agree,  
20 disagree, or are unsure using a 3-point scale. The total score thus ranges from 0 to 14, with higher  
21 scores indicating stronger agreement with stereotypical beliefs. For the present study, internal  
22 reliability calculated with McDonald's omega was poor ( $\omega^{\text{Pre}} = .26$ ,  $\omega^{\text{Post}} = 0.53$ ) and contrasts with the  
23 good indices from the original study (ranging from 0.71 to 0.73) [38]. These results suggest that the 8  
24 items may assess different facets of negative stereotypes.

25

26 2.3.2.3. *Knowledge Test of Mental Illness (KT-MI)* [39]

27

28 Implicit stereotypes were assessed in order to reduce the effects of social desirability as much  
29 as possible, which was done via the Knowledge Test of Mental Illness. The test has 14 questions and is  
30 based on an error-choice approach (that is, no correct response is presented). The questions target the  
31 course of illness (e.g., symptoms, etiology, and prognosis) or interpersonal issues (e.g., theft,  
32 homeless, and marriage), and participants are asked to choose between two proposals (e.g., true/false;  
33 25%/75%). Each item assesses prejudice (overestimation of bad outcomes) toward people with  
34 schizophrenia. The total score ranges from 0 to 14, with higher scores indicating greater prejudice

1 [39]. Test-retest reliability of the original English version ranged from fair to good ( $r = 0.50$ ,  $r = 0.70$ ).

### 2 3 2.3.3. *Immersion*

#### 4 5 2.3.3.1. *Gatineau Presence Questionnaire (GPQ)* [40]

6  
7 The Gatineau Presence Questionnaire (GPQ) [40] was used to assess the sense of presence  
8 experienced during the immersion. The GPQ consists of four items rated on a scale of 0–100 assessing  
9 (1) the impression of being there, (2) the extent to which the experience seems real, (3) the awareness  
10 of the virtual environment as being artificial, and (4) the feeling of being in the physical office instead  
11 of the virtual environment. The four items examine the sense of presence, with higher scores  
12 indicating a higher sense of presence. Internal reliability was acceptable ( $\omega = 0.71$ ). Social presence  
13 was evaluated with two additional items from Makransky et al. [41] asking participants to rate (5) the  
14 feeling of being in the presence of other persons and (6) the feeling that the people in the environment  
15 were aware of them. High scores indicate a high sense of social presence. A final item assessed the  
16 degree of cyber-sickness induced by the environment.

### 17 18 2.4. *Procedure*

19  
20 The experiment was carried out between May and November 2021. The entire procedure was  
21 completed online. The investigator and participants were connected via the Teams platform to provide  
22 links to experimental tasks and questionnaires. For the two conditions including an immersion (360IV  
23 and 360IV + ET), participants received a Google Cardboard (a low-cost VR headset). The  
24 functionality of the participants' Google Cardboard and smartphone was verified by the experimenter  
25 before starting the experiment.

26  
27 Insert Fig. 1 about here

28  
29 After providing informed consent, participants were pseudo-randomly assigned to one of the  
30 three conditions (360IV, 360IV + ET, or control; see Fig. 1) and completed the following pre-test  
31 questionnaires: a demographic questionnaire, IRI (dispositional empathy), KT-MI (implicit stigma),  
32 SDS (social distance), STP (stereotypes towards psychosis), and SIRI (situational empathy). Next, all  
33 participants read the descriptive information about AVH, and then participants from the 360IV + ET

1 condition only were sent a link with the empathic task and a text box to write their thoughts online.  
2 The text boxes were used to make sure that participants carried out the task (supplementary materials,  
3 section 3b).

4         Once the ET was completed for the 360IV + ET condition and directly after the pre-test  
5 questionnaires for the 360IV condition, the experimenter invited the participant to watch the 360IV  
6 with Google Cardboard. In order to simulate the overwhelming feelings of AVH, participants were  
7 instructed to plan a birthday dinner during the immersion (complete instructions are provided in  
8 supplementary materials, section 4). The birthday dinner task was chosen because prospective thinking  
9 that involves the planning of future events is a common activity of daily life [42]. In addition, it  
10 involves cognitive processes that require attentional resources (e.g., working memory and planning),  
11 so it may be affected by voice-induced interferences. Finally, this task could be performed at a  
12 distance without any interaction with the physical environment.

13         The execution of the task was verified directly after the immersion through a visual analogue  
14 scale (VAS) (“On a scale ranging from 0 to 100, please rate the extent to which you were able to  
15 complete the birthday dinner task”; the results are presented in the supplementary materials, section  
16 4b). Immersive properties were then assessed with the GPQ. As the GPQ and the VAS specifically  
17 concerned the immersion task, they were not given to the participants in the control group. Finally, all  
18 participants completed the post-test questionnaires (SIRI, KT-MI, SDS, and STP) and were asked to  
19 guess the aim of the study. A response stipulating an influence on empathy or stigmatization through  
20 the experiment led to exclusion from the study. Participants from the control condition completed the  
21 post-test questionnaires directly after having read the description of AVH.

22

## 23 *2.5. Statistical analyses*

24

25         Analyses were carried out using JASP 0.14.1. Group differences for demographic data, pre-  
26 test empathy, and pre-test stigma and immersive properties were tested with one-way ANOVAs and  
27 chi-squared analyses. In addition, as the sample was composed of psychology students who might  
28 have different scores of empathies and social distance compared to the general population,  
29 comparison-of-means tests were performed. Scores of the samples were compared to those of samples  
30 from the general Belgian population from previous studies [43,44].

31         Firstly, one-way repeated ANOVAs were performed to examine any interaction effects  
32 between the intervention and conditions on situational empathy (SIRI) and stigma (STP, SDS, and KT-  
33 MI). Next, post-hoc linear contrasts were carried out to identify the conditions where an effect of the

1 intervention was observed. A correction for multiple testing was then applied with the help of the  
2 Benjamini–Hochberg procedure [45]. Given the poor levels of internal reliability for the STP indices,  
3 Wilcoxon tests were conducted on each item separately.

4 Second, exploratory Pearson’s correlations were examined between immersive properties  
5 (place presence, social presence, and cybersickness) and the changes between pre- and post-test ( $\Delta X = X^{\text{pre-test}} - X^{\text{post-test}}$ ) of empathy and stigma for measures that demonstrated significant changes in the  
6 first analyses. Due to multiple testing, a correction was applied with the help of a Benjamini-Hochberg  
7 procedure [45]. Finally, to explore the empathic processes occurring during the empathic task, the  
8 thoughts reported by the participants were briefly examined qualitatively. After an in-depth reading,  
9 the texts were coded according to the following criteria: (1) whether the perspective was taken as a  
10 first or a third person, (2) whether it included negative feelings towards (a) the voices and (b) social  
11 interactions in the context of hearing voices, and (3) coping strategies. The codes were applied  
12 separately by the co-first authors and discussed when there was disagreement.  
13

### 15 3. Results

#### 17 3.1. Participants

19 One participant from the 360IV + ET condition guessed the aim of the study and was excluded  
20 from any analyses. Equivalence between conditions in terms of age, academic level, and gender  
21 proportion was confirmed by a one-way ANOVA on age and two Pearson’s chi-squared test on gender  
22 and level of education (Table 1). Additional one-way ANOVAs revealed that the three conditions were  
23 also comparable in terms of pre-test dispositional and situational empathy (IRI, SIRI), pre-test stigma  
24 (KT-MI, STP, SDS), and immersive properties (GPQ, VAS) (Table 2).

25 Regarding the representativeness of the sample compared to others issued from general  
26 population, scores of dispositional empathy (IRI) and social distance (SDS) were gathered into one  
27 total sample as the three conditions were equivalent at baseline. Comparison of mean tests revealed  
28 that for all subscales (perspective taking, fantasy, empathic concern, and personal distress), the scores  
29 for psychology students were significantly higher compared to the general population (all  $p < 0.05$ ).  
30 Similarly, SDS levels of the present sample was significantly lower as compared with Belgian  
31 paramedical students [44] ( $p < 0.05$ ) (see supplemental material, section 5). Finally, concerning  
32 immersive properties, t-tests for independent samples revealed no significant differences between both  
33 experimental conditions regarding the GPQ and the VAS in terms of the birthday dinner task. This  
34 suggests that participants were equally immersed in both experimental conditions.

1

2 3.2. *Simulation intervention effect*

3

4 One-way repeated ANOVAs (Table 3) were conducted on situational empathy (SIRI) and  
5 stigma (KT-MI, STP, SDS) to examine the intervention effect across the three groups. Regarding  
6 empathy, the results revealed a small significant interaction between the intervention and condition on  
7 the SIRI [ $F(2, 117) = 5.58; p = 0.005; \omega^2 = 0.02^5$ ]. In particular, post-hoc contrast analyses revealed  
8 significant and medium increases of empathy in participants from the 360IV condition [ $t(117) = 3.46;$   
9  $p < 0.001; d = 0.67^6$ ] and the 360IV + ET condition [ $t(117) = 4.49; p < 0.001; d = 0.77$ ], but not for  
10 the control condition [ $t(117) = -0.15; p = 0.88; d = 0.30$ ]. The results were similar when the two SIRI  
11 subscales (empathic concern and perspective taking) were taken separately. These results suggest that  
12 participants experienced an increase of situational empathy after both interventions that included the  
13 360IV, while participants from the control group did not.

14 Regarding measures of stigma, the results revealed no interaction effects of the intervention on  
15 the SDS, STP, and KT-MI (Table 3). As specific hypotheses were stated *a priori* for each condition,  
16 post-hoc contrast analyses were carried out. When applying post hoc contrast analyses, the results  
17 revealed significant and large increases of STP after the intervention in all conditions, including the  
18 360IV [ $t(117) = 7.42; p < 0.001; d = 1.29$ ], 360IV + ET [ $t(117) = 6.92; p < 0.001; d = 0.97$ ], and  
19 control [ $t(117) = 7.86; p < 0.001; d = 1.03$ ]. Analyses carried out on each item revealed only one  
20 significant difference for the sixth item of the 360IV condition. However, the difference did not remain  
21 significant after Benjamini-Hochberg correction (see supplementary materials, section 6). No  
22 significant results were found for the KT-MI or the SDS. Taken together, these results suggest that  
23 participants from all conditions, including the control condition, experienced an increase of explicit  
24 stereotypes (STP), but not an increase of implicit stereotypes (KT-MI) or social distance (SDS).

25

26 3.3. *Impact of immersive properties on empathy and stigma*

27

28 The relationship between the change of empathy and stigma ( $\text{delta} = X^{\text{pre-test}} - X^{\text{post-test}}$ ) and the  
29 sense of place presence, social presence, and cybersickness were examined using exploratory

---

<sup>5</sup> Field [61] suggested that  $\omega^2 = 0.01$  represents a small effect size;  $\omega^2 = 0.06$  a medium one and 0.14 a large effect size.

<sup>6</sup> Cohen (1992) [60] suggested that  $d = 0.2$  should be considered as a small effect size, while  $d = 0.5$  represents a medium effect size and  $d = 0.8$  a large effect size.

1 Pearson's correlations. The results related to the change of SIRC revealed one significant positive  
2 correlation for the score of social presence ( $r = 0.37$ ;  $p < 0.001$ ), but not for sense of presence ( $r = 0.19$ ;  
3  $p = 0.083$ ). The results revealed no significant correlations between the change of STP and immersive  
4 properties. These results suggest that higher senses of place presence and social presence during the  
5 immersion were significantly associated with a higher increase of empathy but were not related to an  
6 increase of explicit stereotypes.

### 8 *3.4. Qualitative content of the empathic task*

9

10 Within a minute, the participants wrote down their thoughts using 18 to 149 words. The  
11 complete transcriptions with codes can be retrieved in section 3b in the supplementary materials. Most  
12 of them (29/41) adopted a first-person perspective, while the others adopted a third-person perspective  
13 (a person suffering from schizophrenia or an impersonal perspective). The participants reported a  
14 variety of negative feelings associated with the voices themselves (32/40) (e.g., anxiety, stress, anger,  
15 being confused or overwhelmed, losing self-esteem) or with social interactions in the context of  
16 hearing voices (19/41) (e.g., feeling ashamed, inferior, or observed; being afraid to be seen as mad).  
17 Finally, participants reported a variety of coping strategies (23/41) (e.g., trying to concentrate on one  
18 aspect of the situation, isolating oneself).

## 19 **4. Discussion**

20

21 The aim of present study was to examine the effect of a remotely administered 360IV SI on  
22 empathy and stigma in a population of psychology students. To the best of our knowledge, the  
23 utilization of a 360IV as a SI is reported for the first time in the present study. Overall, the study's  
24 hypotheses were only partially supported. While the results confirmed an increase of empathy after  
25 exposure to both 360IV conditions, mixed results appeared regarding stigma. In particular, all  
26 conditions, including the control condition, were associated with an increase of explicit stereotypes,  
27 and no change was observed regarding social distance for any of the three conditions. Taken together,  
28 these results are in line with current SI studies, which reveal consistent findings regarding empathy but  
29 reveal inconsistent findings concerning stigma [10,11].

30 Beginning with the increase of empathy, the results from the present study are in accordance  
31 with previous SI studies using auditory [12] or VR [18,19] SI and confirm the ability of a 360IV SI to  
32 elicit empathy. Similar to the study by Kalyanaraman et al., [19] a short-duration immersion (2.30  
33 minutes) was sufficient to produce effects on students' degree of empathy. Although comparisons  
34 should be carried out with caution due to differences in questionnaires and methodologies used across

1 studies, differences in effect sizes across devices are worth considering. More precisely, the effect  
2 sizes reported with auditory [12], VR [18,19], and 360IV SIs were small ( $d = 0.34$ ), large ( $\omega^2 = 0.21$   
3 and  $d = 2.57$ ), and medium ( $d$  ranging from 0.57 to 0.78), respectively, suggesting good immersive  
4 experiences in eliciting empathy, particularly for VR.

5 This hypothesis is in agreement with several authors suggesting that multi-sensoriality  
6 facilitates the perspective-taking process of empathy [8]. However, further studies are needed to  
7 precisely compare the effect of the three technologies. As a result, the use of remotely and low-cost  
8 360IV could be presented as combining the respective advantages of auditory and VR SI of being  
9 easily and largely disseminated and highly eliciting due to multi-sensoriality. This is particularly  
10 notable in societal contexts such as pandemic periods, in which social contacts had to be reduced.

11 Eliciting empathy has been proposed as a promising approach to reduce stigma [8, 9].  
12 However, the present results suggest that this relationship may be not as simple. Beginning with the  
13 desire for social distance (the second measure of stigma), the results indicate the absence of change in  
14 all three conditions, which was unexpected and contrasted with the three previous SI studies using  
15 either headphones or VR [14, 19]. Regarding stereotypes, an increase of explicit (STP) but not implicit  
16 (KT-MI) stereotypes was observed in all three conditions. Compared to the increase in attitudes  
17 reported in previous VR studies [18,19], this increase was also unexpected. Such an increase should be  
18 interpreted with caution due to the weak internal consistency levels of the STP (McDonalds' omega =  
19 0.26 at pre-test and 0.53 at post-test). Given the lack of acceptable levels of internal consistency of the  
20 STP and the apparent multidimensionality of the items, analyses were then performed on each item to  
21 understand the nature of this increase. These analyses did not reveal any significant changes after the  
22 application of Benjamini-Hochberg correction, thus suggesting that the increases observed in all three  
23 conditions are not due to one particular dimension.

24 Nevertheless, when looking at studies assessing the effect of SI on stereotypes in other  
25 stigmatized populations (those who are elderly, dyslexic, and overweight), a similar increase in  
26 stereotypes and negative attitude appeared [46–48]. One main hypothesis for these negative changes  
27 relies on the possibly increased awareness of the limitations and difficulties caused by the disability  
28 [46]. In addition, due the short duration of the SI, this increase of awareness did not take into account  
29 the coping mechanisms acquired by people suffering from a disability at long term [48]. The addition  
30 of these two components (awareness of limitations and lack of knowledge about coping strategies)  
31 might actually strengthen the stereotypes, which could explain the observed increase.

32 The fact that the STP increased in all conditions, including the control condition, suggests that  
33 the written description of AVH alone was potentially sufficient to increase the negative beliefs  
34 captured by the STP. However, this relationship between the written description and negative beliefs  
35 remains hypothetical due to the absence of a condition without the written description. The written



1 description was similar to information usually provided to students during lectures in traditional  
2 psychology classes. This emphasizes the importance of how information is communicated to students  
3 in order to avoid increasing stereotypes during university lectures. For instance, recent systematic  
4 reviews [49,50] revealed that endorsing biogenetic causal beliefs about a variety of psychopathologies  
5 was associated with increased stigma and negative attitudes.

6 It should also be noted that the addition of an ET had no particular effect on participants'  
7 scores, which did not replicate the results of Kalyanaraman et al. [19]. The fact that a significant  
8 proportion of participants adopted a third-person perspective during this ET could be one element in  
9 explaining its lack of effect. Indeed, this third-person perspective could maintain a social distance. In  
10 addition, some of the feelings described in this task (e.g., fear of being seen as a fool) could illustrate  
11 the activation of stereotypes before immersion. Therefore, the positive impact of the ET on social  
12 distance and stereotypes remains to be replicated, and the conditions for this positive impact need to  
13 be investigated further.

14 With regard to the STP and the lack of adequate internal consistency, this result contrasts with  
15 the original study [38]. One possible explanation for this could be the change of stereotype contents  
16 over time in the population (from 2003 to 2022). Accordingly, beliefs related to dangerousness and  
17 unpredictability toward psychosis have been found to evolve during the first decade of the 21<sup>st</sup> century  
18 [51]. This evolution could be responsible for a weakening of correlations between items. Indeed, an  
19 exploratory matrix correlation between the STP items revealed that only the two pairs of items (items  
20 1 and 6 and items 5 7) were significantly associated. For future studies, the Opening Minds Scale for  
21 Health Care Providers [52] may represent an alternative to the STP. This scale assesses three facets of  
22 stigma (attitudes, social distance, and disclosure) towards people with mental illness and has  
23 satisfactory internal consistency indices (ranging from 0.74 to .79 for the general scale).

24 Finally, analyses of immersive properties revealed that changes in empathy correlated  
25 significantly and positively with the sense of social presence. Although this relationship requires  
26 experimental designs to infer causalities, it suggests the importance of considering the active factors  
27 that are able to trigger illusions of social presence when constructing 360IVs. For instance, the realism  
28 and the simulation of basic social interactions (e.g., eye contact) have been suggested to enhance both  
29 illusions of presence and illusions of social presence [53–55]. However, further studies are needed to  
30 elucidate the precise component of immersive material leading to optimistic empathic responses. One  
31 interesting but very poorly investigated illusion concerns the sense of embodiment—that is, the  
32 illusion of being incorporated into a virtual body [56–58]. This type of illusion has been reproduced in  
33 360IV [58] and should be considered as particularly promising regarding empathy and perspective-  
34 taking processes.

35 In summary, when compared to literature in the field, several observations can be raised. First,

1 similarly to our results, an increase of empathy is observed after SI, either in the context with  
2 immersive [18,19] or non-immersive experiences [12] and regardless of the type of measure.  
3 Unfortunately, several adverse effects were also observed, with results still lacking consistency. In the  
4 present study, an increase of stereotypes was observed, whereas no difference [13] and even more  
5 improvements [18,19] were previously reported. Regarding the two studies showing improvement, the  
6 measures consisted of self-reported scales tailored from other areas of stigma for the purpose of the  
7 study [18,19], while the other did not report its measures [13]. Regarding social distance, no change  
8 was observed in the present study, whereas in previous immersive and non-immersive studies [13, 19],  
9 an increase in social distance willingness has been reported after the SI [14]. These studies measured  
10 social distance with the help of either standard self-reported measures or self-reported measures based  
11 on a clinical situation.

12 In conclusion, regardless of the type of design and the type of self-reported measures used, the  
13 overall results showed (1) an increase in empathy but (2) a deleterious effect on either the stereotype  
14 measures or the social distance desire measures. Overall, these findings have important theoretical and  
15 practical implications regarding destigmatization interventions. In terms of theoretical implications,  
16 they highlight the importance of better understanding the processes mediating or moderating the  
17 relationship between empathy and stigma. In terms of practical implications, the present results likely  
18 indicate the need to integrate SI into more comprehensive teaching strategies including information,  
19 contact, or testimonies. Such an approach has recently been adopted in a pre-post study [59] that  
20 combined a SI with a presentation of an individual diagnosed with schizophrenia (contact  
21 intervention) for pharmaceutical students. This combination had a significant positive effect on the  
22 different facets of stigma including attitude, disclosure, and social distance.

23 The present study had several limitations that are worth mentioning. First, similar to previous  
24 studies, this study only included self-reported measures, which prevents us from drawing any  
25 conclusions regarding the actual impact of the devices on participants' behaviors (and more precisely  
26 empathic communication) toward people suffering from AVH. Indeed, there is a lack of studies  
27 assessing the amount of change needed on the scales assessing stereotypes (STP) and in empathy  
28 (SIRI) to allow the observation of an impact in actual practice. Further studies should thus address this  
29 issue and consequently the increase observed in the present study should be interpreted with caution.

30 We suggest that a more thorough evaluation of the effects of SI is needed. In addition to self-  
31 reported measures, this comprehensive assessment should include objective assessments of empathic  
32 communication, as well as patients' assessment of MHP empathy in the relationship. These studies  
33 would be valuable given the promising potential of SI via 360IV. Indeed, this methodology presents  
34 many advantages: it can be developed with few technical skills and represents a cost-effective  
35 possibility of eliciting long-distance learning to a large group of students. Therefore, 360IV could be

1 an effective pedagogical tool to be used in order to elicit empathy, albeit not before the mixed and  
2 unclear results regarding stigma are better understood.

3 Another limitation is related to the absence of a strict control condition. Indeed, in the present  
4 study, participants in the control condition had to read a short information notice regarding AVH,  
5 which could have had an impact on our results, particularly on the increase of stereotypes. In parallel,  
6 this choice was motivated by the intention of providing all participants with a common ground of  
7 information on psychosis and AVH. Indeed, since the students came from different universities as well  
8 as different years of study, it was not feasible to control their prior familiarity with AVH.

9 This leads to the third limit of the present study: the level of exposure or training of  
10 participants with psychosis or AVH was unknown. The description of AVH aimed to compensate for  
11 this limit, but it is likely that differences remained. Finally, the present study only included psychology  
12 students as potential MHPs being educated. As it was confirmed in our statistical analyses, this  
13 population may have different empathic and stigma sensitivities compared to other MHP groups (e.g.,  
14 physicians, pharmacists, and nurses). To the best of our knowledge, little is known about whether such  
15 interventions have a greater benefit on MHPs during their initial training or when they are already  
16 practicing. Therefore, studies that include other MHP groups are needed.

17

## 18 **5. Conclusion**

19

20 This study adds two main innovations to current knowledge. First, the immersive technology  
21 used in this study is 360IV, whereas all other studies have used VR to the best of our knowledge (e.g.,  
22 [18,19]). Second, our results suggested that simulation can elicit empathy but provided mixed and  
23 unclear results regarding stigma. We suggest that simulation should be followed by contact with a  
24 patient partner who could answer any questions that participants might have after their (immersive)  
25 AVH experience. The combination of both interventions could provide better results and deserves to  
26 be examined in future studies.

## 27 **6. References**

- 28 [1] A.M. Parcesepe, L.J. Cabassa, Public stigma of mental illness in the united states: A systematic  
29 literature review, *Adm. Policy Ment. Heal. Ment. Heal. Serv. Res.* 40 (2013) 384–399.  
30 <https://doi.org/10.1007/s10488-012-0430-z>.
- 31 [2] K.M. Valery, A. Prouteau, Schizophrenia stigma in mental health professionals and associated  
32 factors: A systematic review, *Psychiatry Res.* 290 (2020) 113068.  
33 <https://doi.org/10.1016/j.psychres.2020.113068>.

- 1 [3] A. Llerena, M.C. Cáceres, E.M. Peas-LLedó, Schizophrenia stigma among medical and nursing  
2 undergraduates, *Eur. Psychiatry.* 17 (2002) 298–299. [https://doi.org/10.1016/S0924-](https://doi.org/10.1016/S0924-9338(02)00672-7)  
3 [9338\(02\)00672-7](https://doi.org/10.1016/S0924-9338(02)00672-7).
- 4 [4] K. Nieweglowski, S. Qin, D. Paniagua, P.W. Corrigan, *Understanding the Impact of Mental*  
5 *Health Stigma and the Role of Clinicians as Allies*, Elsevier Inc., 2020.  
6 <https://doi.org/10.1016/b978-0-12-815012-2.00003-1>.
- 7 [5] P.W. Corrigan, A. Watson, *Understanding the impact of stigma on people with mental illness*,  
8 *World Psychiatry.* 1 (2002) 16–20.
- 9 [6] R.P. Vilhauer, *Stigma and need for care in individuals who hear voices*, *Int. J. Soc. Psychiatry.*  
10 63 (2017) 5–13. <https://doi.org/10.1177/0020764016675888>.
- 11 [7] S. Knaak, E. Mantler, A. Szeto, *Mental illness-related stigma in healthcare: Barriers to access*  
12 *and care and evidence-based solutions*, *Healthc. Manag. Forum.* 30 (2017) 111–116.  
13 <https://doi.org/10.1177/0840470416679413>.
- 14 [8] P. Bertrand, J. Guegan, L. Robieux, C.A. McCall, F. Zenasni, *Learning empathy through virtual*  
15 *reality: Multiple strategies for training empathy-related abilities using body ownership illusions*  
16 *in embodied virtual reality*, *Front. Robot. AI.* 5 (2018) 1–18.  
17 <https://doi.org/10.3389/frobt.2018.00026>.
- 18 [9] C.D. Batson, M.P. Polycarpou, E. Harmon-Jones, H.J. Imhoff, E.C. Mitchener, L.L. Bednar, T.R.  
19 Klein, L. Highberger, *Empathy and Attitudes: Can Feeling for a Member of a Stigmatized Group*  
20 *Improve Feelings Toward the Group?*, *J. Pers. Soc. Psychol.* 72 (1997) 105–118.  
21 <https://doi.org/10.1037/0022-3514.72.1.105>.
- 22 [10] A.J. Morgan, N.J. Reavley, A. Ross, L.S. Too, A.F. Jorm, *Interventions to reduce stigma towards*  
23 *people with severe mental illness: Systematic review and meta-analysis*, *J. Psychiatr. Res.* 103  
24 (2018) 120–133. <https://doi.org/10.1016/j.jpsychires.2018.05.017>.
- 25 [11] S. Ando, S. Clement, E.A. Barley, G. Thornicroft, *The simulation of hallucinations to reduce the*  
26 *stigma of schizophrenia: A systematic review*, *Schizophr. Res.* 133 (2011) 8–16.  
27 <https://doi.org/10.1016/j.schres.2011.09.011>.
- 28 [12] W. Bunn, J. Terpstra, *Cultivating Empathy for the Mentally Ill Using Simulated Auditory*  
29 *Hallucinations* William, *Acad. Psychiatry.* 33 (2009) 457–460.  
30 <https://doi.org/10.1176/appi.ap.33.6.457>.
- 31 [13] A. Doty, *Hallucination Simulations: A Stigma-Reduction Strategy for Schizophrenia*, Roosevelt  
32 University Hallucination, 2016.

- 1 <https://www.infodesign.org.br/infodesign/article/view/355><http://www.abergo.org.br/revista/index.php/ae/article/view/731><http://www.abergo.org.br/revista/index.php/ae/article/view/269><http://www.abergo.org.br/revista/index.php/ae/article/view/106>.
- 2
- 3
- 4 [14] S.A. Brown, Implementing a brief hallucination simulation as a mental illness stigma reduction  
5 strategy, *Community Ment. Health J.* 46 (2010) 500–504. <https://doi.org/10.1007/s10597-009-9229-0>.
- 6
- 7 [15] A. Kittel, P. Larkin, I. Cunningham, M. Spittle, 360° Virtual Reality: A SWOT Analysis in  
8 Comparison to Virtual Reality, *Front. Psychol.* 11 (2020) 1–5.  
9 <https://doi.org/10.3389/fpsyg.2020.563474>.
- 10 [16] S. Ventura, L. Badenes-Ribera, R. Herrero, A. Cebolla, L. Galiana, R. Banõs, Virtual Reality as  
11 a Medium to Elicit Empathy: A Meta-Analysis, *Cyberpsychology, Behav. Soc. Netw.* 23 (2020)  
12 667–676. <https://doi.org/10.1089/cyber.2019.0681>.
- 13 [17] N. Yee, J. Bailenson, Walk a mile in digital shoes: The impact of embodied perspective-taking  
14 on the reduction of negative stereotyping in immersive virtual environments, in: *Proc.*  
15 *PRESENCE 2006 9th Annu. Int. Work. Presence*, Cleveland, 2006: pp. 147–156.
- 16 [18] N.J. Formosa, B.W. Morrison, G. Hill, D. Stone, Testing the efficacy of a virtual reality-based  
17 simulation in enhancing users’ knowledge, attitudes, and empathy relating to psychosis, *Aust. J.*  
18 *Psychol.* 70 (2018) 57–65. <https://doi.org/10.1111/ajpy.12167>.
- 19 [19] S. Kalyanaraman, D.L. Penn, J.D. Ivory, A. Judge, The virtual doppelganger: Effects of a virtual  
20 reality simulator on perceptions of schizophrenia, *J. Nerv. Ment. Dis.* 198 (2010) 437–443.  
21 <https://doi.org/10.1097/NMD.0b013e3181e07d66>.
- 22 [20] X. Pan, A.F. d. C. Hamilton, Why and how to use virtual reality to study human social interaction:  
23 The challenges of exploring a new research landscape, *Br. J. Psychol.* 109 (2018) 395–417.  
24 <https://doi.org/10.1111/bjop.12290>.
- 25 [21] M. Slater, S. Wilbur, A Framework for Immersive Virtual Environments (FIVE): Speculations  
26 on the Role of Presence in Virtual Environments, *Presence Teleoperators Virtual Environ.* (1997)  
27 12–13. <https://doi.org/10.1162/pres.1997.6.6.603>.
- 28 [22] F. Biocca, C. Harms, J.K. Burgoon, Toward a More Robust Theory and Measure of Social  
29 Presence: Review and Suggested Criteria, 2003. <https://doi.org/10.1162/105474603322761270>.
- 30 [23] A. Chirico, A. Gaggioli, When Virtual Feels Real: Comparing Emotional Responses and  
31 Presence in Virtual and Natural Environments, *Cyberpsychology, Behav. Soc. Netw.* 22 (2019)  
32 220–226. <https://doi.org/10.1089/cyber.2018.0393>.

- 1 [24] C. Della Libera, E. Quertemont, J. Laloyaux, B. Thonon, F. Larøi, Using 360° immersive videos  
2 to assess paranoia in a non-clinical population, *Cogn. Neuropsychiatry*. 26 (2021) 357–375.  
3 <https://doi.org/10.1080/13546805.2021.1956885>.
- 4 [25] (Masked for anonymous review)
- 5 [26] D. Pimentel, S. Kalyanaraman, Y.H. Lee, S. Halan, Voices of the unsung: The role of social  
6 presence and interactivity in building empathy in 360 video, *New Media Soc.* 23 (2021) 2230–  
7 2254. <https://doi.org/10.1177/1461444821993124>.
- 8 [27] (Masked for anonymous review)
- 9 [28] N.S. Schutte, E.J. Stilinović, Facilitating empathy through virtual reality, *Motiv. Emot.* 41 (2017)  
10 708–712. <https://doi.org/10.1007/s11031-017-9641-7>.
- 11 [29] S.S. Sundar, J. Kang, D. Oprean, Being There in the Midst of the Story: How Immersive  
12 Journalism Affects Our Perceptions and Cognitions, *Cyberpsychology, Behav. Soc. Netw.* 20  
13 (2017) 672–682. <https://doi.org/10.1089/cyber.2017.0271>.
- 14 [30] F. Faul, E. Erdfelder, A. Buchner, A.G. Lang, Statistical power analyses using G\*Power 3.1:  
15 Tests for correlation and regression analyses, *Behav. Res. Methods*. 41 (2009) 1149–1160.  
16 <https://doi.org/10.3758/BRM.41.4.1149>.
- 17 [31] M. Stephane, P. Thuras, H. Nasrallah, A.P. Georgopoulos, The internal structure of the  
18 phenomenology of auditory verbal hallucinations, *Schizophr. Res.* 61 (2003) 185–193.  
19 [https://doi.org/10.1016/S0920-9964\(03\)00013-6](https://doi.org/10.1016/S0920-9964(03)00013-6).
- 20 [32] F. Larøi, I.E. Sommer, J.D. Blom, C. Fernyhough, D.H. Ffytche, K. Hugdahl, L.C. Johns, S.  
21 McCarthy-Jones, A. Preti, A. Raballo, C.W. Slotema, M. Stephane, F. Waters, The characteristic  
22 features of auditory verbal hallucinations in clinical and nonclinical groups: State-of-the-art  
23 overview and future directions, *Schizophr. Bull.* 38 (2012) 724–733.  
24 <https://doi.org/10.1093/schbul/sbs061>.
- 25 [33] M.. Davis, Measuring individual differences in empathy : evidence for a multidimensional  
26 approach, *J. Pers. Soc. Psychol.* 44 (1983) 113–126.
- 27 [34] A.L. Gilet, N. Mella, J. Studer, D. Griehn, G. Labouvie-Vief, Assessing dispositional empathy in  
28 Adults: A french validation of the interpersonal reactivity index (IRI), *Can. J. Behav. Sci.* 45  
29 (2013) 42–48. <https://doi.org/10.1037/a0030425>.
- 30 [35] B.G. Link, F.T. Cullen, J. Frank, J. Wozniak, The Social Rejection of Former Mental Patients:  
31 Understanding Why Labels Matter, *Am. J. Sociol.* 92 (1987).

- 1 [36] L.J. Peter, S. Schindler, C. Sander, S. Schmidt, H. Muehlan, T. McLaren, S. Tomczyk, S.  
2 Speerforck, G. Schomerus, Continuum beliefs and mental illness stigma: A systematic review  
3 and meta-analysis of correlation and intervention studies, *Psychol. Med.* 51 (2021) 716–726.  
4 <https://doi.org/10.1017/S0033291721000854>.
- 5 [37] Y. Wei, P.J. McGrath, J. Hayden, S. Kutcher, Mental health literacy measures evaluating  
6 knowledge, attitudes and help-seeking: A scoping review, *BMC Psychiatry.* 15 (2015).  
7 <https://doi.org/10.1186/s12888-015-0681-9>.
- 8 [38] B. Schulze, M. Richter-Werling, H. Matschinger, M.C. Angermeyer, Crazy? So what!? Effects  
9 of a school project on mental health and illness on students' attitudes, *Acta Psychiatr. Scand.* 107  
10 (2003) 142–150. [https://doi.org/10.1016/s0924-9338\(02\)80370-4](https://doi.org/10.1016/s0924-9338(02)80370-4).
- 11 [39] P.J. Michaels, P.W. Corrigan, Measuring mental illness stigma with diminished social desirability  
12 effects, *J. Ment. Heal.* 22 (2013) 218–226. <https://doi.org/10.3109/09638237.2012.734652>.
- 13 [40] M. Laforest, S. Bouchard, A.M. Crétu, O. Mesly, Inducing an anxiety response using a  
14 contaminated virtual environment: Validation of a therapeutic tool for obsessive-compulsive  
15 disorder, *Front. ICT.* 3 (2016) 1–11. <https://doi.org/10.3389/fict.2016.00018>.
- 16 [41] G. Makransky, L. Lilleholt, A. Aaby, Development and validation of the Multimodal Presence  
17 Scale for virtual reality environments: A confirmatory factor analysis and item response theory  
18 approach, *Comput. Human Behav.* 72 (2017) 276–285.  
19 <https://doi.org/10.1016/j.chb.2017.02.066>.
- 20 [42] L. Kvavilashvili, J. Rummel, On the Nature of Everyday Prospection: A Review and Theoretical  
21 Integration of Research on Mind-Wandering, Future Thinking, and Prospective Memory, *Rev.*  
22 *Gen. Psychol.* 24 (2020) 210–237. <https://doi.org/10.1177/1089268020918843>.
- 23 [43] K. De Corte, A. Buysse, L.L. Verhofstadt, H. Roeyers, K. Ponnet, M.H. Davis, Measuring  
24 empathic tendencies: Reliability and validity of the Dutch version of the interpersonal reactivity  
25 index, *Psychol. Belg.* 47 (2007) 235–260. <https://doi.org/10.5334/pb-47-4-235>.
- 26 [44] J.S. Bell, S.E. Aaltonen, M.S. Airaksinen, D. Volmer, M.S. Gharat, R. Muceniece, A. Vitola, V.  
27 Foulon, F.A. Desplenter, T.F. Chen, Determinants of mental health stigma among pharmacy  
28 students in Australia, Belgium, Estonia, Finland, India and Latvia, *Int. J. Soc. Psychiatry.* 56  
29 (2010) 3–14. <https://doi.org/10.1177/0020764008097621>.
- 30 [45] Y. Benjamini, Y. Hochberg, Controlling the False Discovery Rate : A Practical and Powerful  
31 Approach to Multiple Testing Author ( s ): Yoav Benjamini and Yosef Hochberg Source : Journal  
32 of the Royal Statistical Society . Series B ( Methodological ), Vol . 57 , No . 1 ( 1995 ), Publi, J.

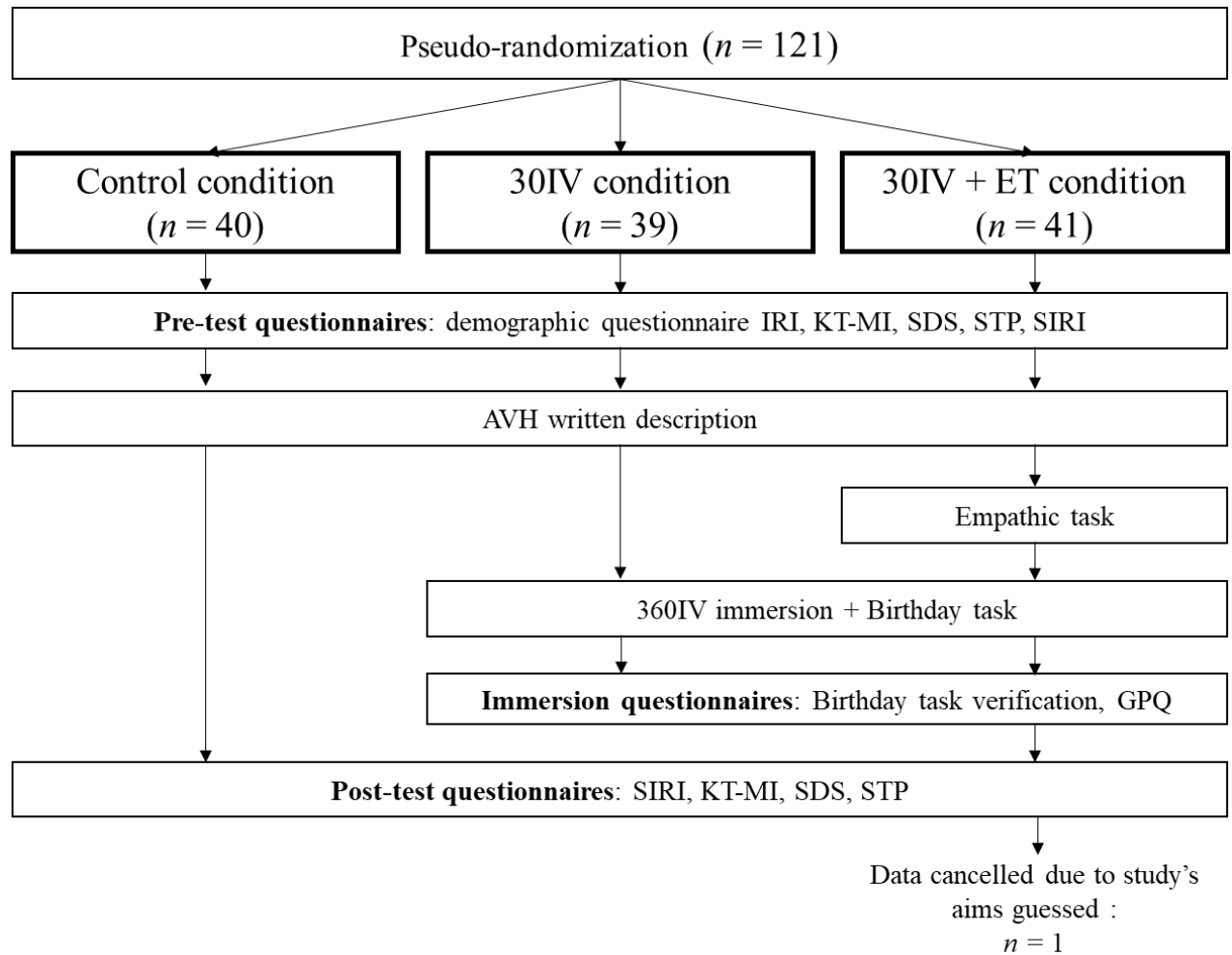
- 1 R. Stat. Soc. 57 (1995) 289–300.
- 2 [46] A.L.G. Lucchetti, G. Lucchetti, I.N. De Oliveira, A. Moreira-Almeida, O. Da Silva Ezequiel,  
3 Experiencing aging or demystifying myths? - impact of different “geriatrics and gerontology”  
4 teaching strategies in first year medical students, *BMC Med. Educ.* 17 (2017) 1–9.  
5 <https://doi.org/10.1186/s12909-017-0872-9>.
- 6 [47] B. Henry, C. Douglass, I. Kostiwa, Effects of participation in an aging game simulation activity  
7 on the attitudes of allied health students toward older adults, *Internet J. Allied Heal. Sci. Pract.* 5  
8 (2007). <https://doi.org/10.46743/1540-580x/2007.1166>.
- 9 [48] M.R. Nario-Redmond, D. Gospodinov, A. Cobb, Crip for a day: The unintended negative  
10 consequences of disability simulations, *Rehabil. Psychol.* 62 (2017) 324–333.  
11 <https://doi.org/10.1037/rep0000127>.
- 12 [49] G. Schomerus, C. Schwahn, A. Holzinger, P.W. Corrigan, H.J. Grabe, M.G. Carta, M.C.  
13 Angermeyer, Evolution of public attitudes about mental illness: A systematic review and meta-  
14 analysis, *Acta Psychiatr. Scand.* 125 (2012) 440–452. <https://doi.org/10.1111/j.1600-0447.2012.01826.x>.
- 15
- 16 [50] J.S. Larkings, P.M. Brown, Do biogenetic causal beliefs reduce mental illness stigma in people  
17 with mental illness and in mental health professionals? A systematic review, *Int. J. Ment. Health*  
18 *Nurs.* 27 (2018) 928–941. <https://doi.org/10.1111/inm.12390>.
- 19 [51] N.J. Reavley, A.F. Jorm, Stigmatising attitudes towards people with mental disorders: Changes  
20 in Australia over 8years, *Psychiatry Res.* 197 (2012) 302–306.  
21 <https://doi.org/10.1016/j.psychres.2012.01.011>.
- 22 [52] G. Modgill, S. Patten, S. Knaak, A. Kassam, A. Szeto, Opening Minds Stigma Scale for Health  
23 Care Providers (OMS-HC): Examination of psychometric properties and responsiveness Geeta,  
24 *BMC Psychiatry.* 14 (2014) 120. <https://doi.org/10.1186/1471-244X-14-120>.
- 25 [53] J.N. Bailenson, J. Blascovich, A.C. Beall, J.M. Loomis, Interpersonal distance in immersive  
26 virtual environments, *Personal. Soc. Psychol. Bull.* 29 (2003) 819–833.
- 27 [54] C.S. Oh, J.N. Bailenson, G.F. Welch, A systematic review of social presence: Definition,  
28 antecedents, and implications, *Front. Robot. AI.* 5 (2018) 1–35.  
29 <https://doi.org/10.3389/frobt.2018.00114>.
- 30 [55] M. van Gisbergen, M. Kovacs, F. Camos, M. van der Heeft, V. Vugts, What We Don’t Know.  
31 The Effect of Realism in Virtual Reality on Experience and Behaviour, in: M.C. tom Dieck, T.  
32 Jung (Eds.), *Augment. Real. Virtual Real. Power AR VR Bus.*, Springer, 2019.



- 1 [56] G. Riva, B.K. Wiederhold, F. Mantovani, Neuroscience of Virtual Reality: From Virtual  
2 Exposure to Embodied Medicine, *Cyberpsychology, Behav. Soc. Netw.* 22 (2019) 82–96.  
3 <https://doi.org/10.1089/cyber.2017.29099.gri>.
- 4 [57] D. Banakou, P. Hanumanthu, M. Slater, Virtual Embodiment of White People in a Black Virtual  
5 Body Leads to a Sustained Reduction in their Implicit Racial Bias, *Front Hum Neurosci.* 10  
6 (2016) 601.
- 7 [58] S. Ventura, A. Cebolla, J. Latorre, T. Escrivá-Martínez, R. Llorens, R. Baños, The benchmark  
8 framework and exploratory study to investigate the feasibility of 360-degree video-based virtual  
9 reality to induce a full body illusion, *Virtual Real.* 26 (2022) 323–332.  
10 <https://doi.org/10.1007/s10055-021-00567-6>.
- 11 [59] S.L. Hsia, J. Brooks, E. Yao, K. Gruenberg, P. Finley, Impact of an auditory hallucination  
12 simulation coupled with a speaker diagnosed with schizophrenia on mental illness stigma in  
13 pharmacy students, *Curr. Pharm. Teach. Learn.* 14 (2022) 1397–1403.  
14 <https://doi.org/10.1016/j.cptl.2022.09.022>.
- 15 [60] J. Cohen, Quantitative methods in psychology : A power primer, *Psychol. Bull.* 112 (1992) 155–  
16 159. <https://doi.org/10.1037/0033-2909.112.1.155>.
- 17 [61] A. Field, *Discovering Statistics with IBM SPSS Statistics*, SAGE, Newbury Park, CA, 2013.
- 18
- 19
- 20
- 21

**Tables and figures**

*Figure 1. Schematic representation of the procedure*



*Note.* IRI = Interpersonal Reactivity Index, KT-MI = Knowledge Test of Mental Illness; SDS = Social Distance Scale, STP = Stereotypes Towards Psychosis, SIRI = Situational Interpersonal Reactivity Index, GPQ = Gatineau Presence Questionnaire.

Table 1. Demographic data

	<b>Controls</b> <i>n</i> = 40	<b>360IV</b> <i>n</i> = 39	<b>360IV + ET</b> <i>n</i> = 41		
	Mean ( <i>SD</i> )	Mean ( <i>SD</i> )	Mean ( <i>SD</i> )	F/Chi <sup>2</sup>	<i>p</i>
<b>Age - Mean (SD)</b>	23.13 (4.75)	22.93 (3.68)	22.95 (2.85)	0.03	0.968
<b>Gender - <i>n</i> (%)</b>				2.88	0.578
<i>Men</i>	5 (12.5)	8 (20.51)	4 (9.76)		
<i>Women</i>	34 (85)	31 (79.49)	36 (87.81)		
<i>Not specified</i>	1 (2.5)	0 (0)	1 (2.44)		
<b>Level of study - <i>n</i> (%)</b>				2.64	0.619
<i>Bachelor</i>	21 (52.5)	18 (46.15)	20 (48.78)		
<i>Master</i>	17 (42.5)	21 (53.85)	19 (46.34)		
<i>Post-master</i>	2 (5)	0 (0)	2 (4.88)		
<b>University - <i>n</i> (%)</b>				3.82	0.43
<i>ULiege</i>	34 (85)	30 (76.92)	30 (73.17)		
<i>UCLouvain</i>	0 (0)	1 (2.56)	0 (0)		
<i>ULB</i>	6 (15)	8 (20.51)	11 (26.83)		



Table 2. Mean and equivalence of groups at T1

	<b>Control</b>		<b>360IV</b>		<b>360IV + ET</b>	
	<i>n</i> = 40		<i>n</i> = 39		<i>n</i> = 41	
	<i>Pre</i>	<i>Post</i>	<i>Pre</i>	<i>Post</i>	<i>Pre</i>	<i>Post</i>
	<i>Mean (SD)</i>	<i>Mean (SD)</i>	<i>Mean (SD)</i>	<i>Mean (SD)</i>	<i>Mean (SD)</i>	<i>Mean (SD)</i>
<b>SIRI</b>	18.9 (4.19)	18.7 (5.03)	19.31 (3.76)	21.62 (3.86)	17.52 (5.01)	20.29 (3.98)
<i>EC</i>	10.93 (2.95)	10.8 (3.45)	11.21 (2.46)	12.64 (2.63)	10.17 (3.59)	11.68 (2.81)
<i>PT</i>	7.98 (1.93)	7.9 (2.37)	8.10 (2.19)	8.97 (1.87)	7.24 (2.03)	8.61 (2.06)
<b>STP</b>	3 (1.59)	5.3 (1.86)	2.87 (1.82)	5.08 (2.45)	3 (1.9)	5.07 (1.89)
<b>KTMI</b>	4.63 (2.6)	4.93 (2.72)	5.67 (2.68)	6.18 (2.67)	5 (2.23)	5.59 (2.01)
<b>Social distance</b>	15.43 (3.43)	15.63 (4.26)	15.59 (4.64)	15.85 (6.00)	15.15 (5.32)	15.76 (4.69)
<b>IRI</b>						
<i>Fantasy</i>	19.35 (4.55)	-	19.69 (5.49)	-	17.76 (4.61)	-
<i>PT</i>	20.65 (4.45)	-	21.44 (4.06)	-	19.66 (4.64)	-
<i>EC</i>	22.35 (4.46)	-	22.85 (3.5)	-	21.15 (3.46)	-
<i>Personal distress</i>	13.00 (5.16)	-	12.72 (4.57)	-	13.05 (5.62)	-
<b>Immersive properties</b>						
<i>Presence</i>	-	-	-	17.33 (7.59)	-	20.32 (6.73)
<i>Co-presence</i>	-	-	-	8.97 (5.13)	-	9.63 (4.46)
<i>Cybersickness</i>	-	-	-	2.90 (3.19)	-	3.34 (3.35)
<i>Birthday dinner task</i>	-	-	-	49.28 (28.11)	-	47.32 (30.49)

Table 3. Repeated measure ANOVAs and contrast analyses

	Repeated measure ANOVAs			Contrasts					
	F	<i>p</i>	Eta square	Control <i>n</i> = 39		360IV <i>n</i> = 39		360IV + ET <i>n</i> = 41	
				<i>t</i>	<i>p</i>	<i>t</i>	<i>p</i>	<i>t</i>	<i>p</i>
<b>Situational empathy</b>									
<i>Time*condition</i>	6.27	<b>0.003</b>	0.02	-0.31	0.76	3.48	<b>&lt;.001</b>	4.45	<b>&lt;.001</b>
Empathic concern									
<i>Time*condition</i>	4.94	<b>0.009</b>	0.02	-0.3	0.76	3.41	<b>&lt;.001</b>	3.68	<b>&lt;.001</b>
Perspective taking									
<i>Time*condition</i>	4.83	<b>0.01</b>	0.02	-0.22	0.82	2.57	<b>0.01</b>	4.13	<b>&lt;.001</b>
<b>Stereotypes</b>									
<b><i>STP</i></b>									
<i>Time*condition</i>	0.15	0.86	5.51E-04	7.76	<b>&lt;.001</b>	7.34	<b>&lt;.001</b>	7.08	<b>&lt;.001</b>
<b><i>KTMI</i></b>									
<i>Time*condition</i>	0.18	0.83	5.81E-04	0.87	0.38	1.46	0.14	1.71	0.09
<b>Social distance</b>									
<i>Time*condition</i>	0.09	0.91	3.17E-04	0.28	0.78	0.34	0.72	0.85	0.39

Note. Bold characters indicate *p*-values that remain significant after applying a Benjamini-Hochberg correction for multiple comparisons