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REVIEW EQ1

Virtual Reality as a Medium to Elicit Empathy: A Meta-Analysis

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Abstract

The current meta-analysis aims to investigate and clarify existing research on virtual reality (VR) as a medium to elicit empathy. An exhaustive literature search (updated to February 29, 2020) enabled us to locate seven published articles, yielding a total of nine independent samples. The results reveal positive changes in both empathy and perspective-taking outcomes after VR exposure ($d_+ = 0.44$ [95 percent confidence interval, CI: 0.06–0.81], $p = 0.023$, $d_+ = 0.51$ [95 percent CI: 0.15–0.88], $p = 0.006$, respectively). A potential limitation of this work is the low number of studies included. Implications and directions for theoretical development and empirical research are also discussed.

Keywords: empathy, perspective-taking, prosocial behavior, virtual reality, meta-analysis

Introduction

AU2 THE ORIGIN OF the term empathy can be traced to the German word ''Einfühlung,'' which refers to ''feeling into.'' According to the literature, empathy can be divided into cognitive empathy and emotional or affective empathy.[1] More specifically, cognitive empathy is defined as an intellectual understanding of another person's emotions and mental state while remaining an objective observer, whereas emotional empathy refers to being affected by and sharing another's emotions and matching or corresponding one's emotional reaction to the emotions of another individual.[2] The gold standard model shared by the scientific community is Davis's model,[3] which describes the interaction between cognitive and affective empathy. The model is structured using four factors: (a) perspective taking, referring to the ability to adopt the viewpoint of another person; (b) fantasy, referring to the ability to transpose oneself into the feelings of a fictitious character; (c) empathic concern, referring to the feeling of being involved in others' emotions; and (d) personal distress, regarding the feeling of sorrow about others' pain.

Beyond the multidimensional construct, empathy plays an important role in social relationships. It establishes the basis for positive relationships and communities' well-being and it moderates aggressive behavior.[4,5] Moreover, empathy is an essential factor in medical and psychological treatments and caregiving relationships.[6] On the other hand, the lack of empathy implies the inability to view the world from other individuals' perspectives or be affected by others' feelings, with the risk of having prejudices or violent behaviors.[7,8] Due to its importance, researchers have developed several interventions to increase empathy skills, mainly based on the technique of role-play to take the perspective of another person.[9–13] Previous researches have shown that one of the best ways to foster empathy is the psychological process of perspective taking described above or imaging the world from another person's point of view.[14] Davis suggests that if a person imagines the world from another's perspective, the gap between oneself and the other decreases.[15]

In the past decade, virtual reality (VR) has been found to be an interesting instrument for studying empathy. VR is an advanced form of a human–computer interface that allows the user to interact with and become immersed in a computer-generated environment.[16] Namely, it could be a subjective experience that convinces the individual that the artificial environment where s/he is immersed is real.[17] Thanks to the proper characteristics of VR, it is possible to share and experience the life of someone else and to understand the other point of view. For this, VR is defined as the ultimate empathy machine for its ability to better connect humans to other humans in a profound way than any other forms of media, changing people's perception of each other.[18]

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So far, several studies have found interesting results when using VR to generate an empathic response, such as inducing helping behavior,[19] reducing domestic violence,[20] reducing implicit racial bias,[21] reversing in-group bias,[22] and decreasing prejudice,[23] thus opening the door to new investigations of empathy and VR. However, VR also received the critique of whether it could really be a crucial medium to elicit empathy because empathy is more than simply embodying or taking the perspective of a person in digital media.[24] For example, Bollmer[25] states that VR presumes to acknowledge the experience of another, but it fails to do so in any meaningful way.

The present meta-analysis aims to provide an overview and preliminary evaluation about the effect of VR on empathy. In detail, the main objective is to investigate if VR could significantly change the empathy variable from before to after the exposure, among different contexts and populations.

Methods

The current meta-analysis was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[26]

Study selection criteria

To be included in the meta-analysis, studies had to fulfill the following criteria: (a) be empirical studies published in a peer-reviewed journal; (b) examine the change in empathy and/or perspective taking; (c) have a sample of adult participants from a nonclinical population; (d) include pretest and post-test data; (e) be written in English, Italian, or Spanish; (f) report statistical data that allow us to compute the effect sizes; and (g) have the full text available.

Search strategy

First, a systematic literature search was conducted on the PsycINFO, Scopus, ScienceDirect, and Web of Science databases on September 20th, 2018, and after the review process of this article, it was updated to February 29th, 2020, using the following terms: ''virtual reality'' AND (empathy OR compassion OR ''perspective taking'' OR ''prosocial behavior''). Moreover, the references in the located studies and recent studies were also reviewed, and authors were contacted for missing data.

Search outcome

The initial search procedure led to 3,354 potentially relevant studies. After removing 283 duplicates, 3,071 titles were scanned. From those, 2,525 studies were removed because they did not match the field of our research, and 546 abstracts were scanned. After removing 323 studies because the abstracts did not match the selection criteria, 223 full texts were examined. The selection of the studies was done individually by two researchers (S.V. and R.H.). Disagreements between researchers were resolved through discussion with a third researcher (A.C.) until consensus was reached. The researchers reviewed the full text, providing reasons for exclusion such as not an empirical study ($n=37$); does not examine the change in empathy and/or perspective taking from before to after the VR exposure ($n=63$); does not have a sample of adult participants ($n=28$); or from a nongeneral population ($n=25$); does not have pretest and/or post-test data ($n=27$); not written in English, Italian, or Spanish ($n=6$), does not report statistical data ($n=25$); or full text not available ($n=5$).

At the end of the literature search process, seven studies were selected (Fig. 1). In addition, because several studies ◀F1 reported statistical data for two or more different groups, the database for our meta-analysis included a total of nine independent samples.

Data extraction

A protocol for extracting the characteristics of the studies was produced and applied to each study. The characteristics coded were (a) the year of the study; (b) geographical location; (c) sample size (total and by groups); (d) mean age; (e) sex distribution; (f) main intervention; (g) outcome measure: empathy and perspective taking; and (h) statistics reported to calculate the effect sizes. Finally, the methodological quality of the study was measured on a scale from 0 to 9 points,[27] but with a few adaptations to our selected studies (most of them were studies without a control group). The items that made up the scale were (1) internal validity of the design (including the active control group, nonactive control group, or no control group); (2) random versus nonrandom assignment of participants to the groups; (3) the sample size at the post-test; (4) the use of blinded assessors to measure outcomes; (5) the use of a measurement instrument to assess outcomes that show good psychometric properties (reliability) in the study sample; (6) an acceptable dropout rate; (7) the use of both point measures (e.g., differences in group outcomes or as the outcome for each/all groups) and measures of outcome variability (e.g., standard deviation); (8) appropriate statistical analyses of data (nonparametric methods vs. parametric methods); and (9) calculation of the statistical power; that is, the sample size was calculated to detect an effect. Each item received a score of 1 when the study met a criterion and 0 otherwise. A total quality score was also calculated for each study by adding up all the corresponding item quality scores (range: 0–9), with a higher score indicating higher overall quality.

The coding process was carried out in a standardized and systematic manner, and the data were doubly coded by two independent researchers (L.B.R. and L.G.). Disagreements ◀AU3 during the coding process were resolved by consensus.

Computing effect sizes

The types of designs used in the studies conditioned the selection of the effect size index in our meta-analysis. Only one of the seven articles included a control group. Consequently, our analysis unit was the group, rather than the study, and the effect size index was the standardized mean change score, defined as the difference between the post-test and pretest means divided by the pretest standard deviation: $d = c(m)\ (Mean_{Post} - Mean_{Pre})/S_{Pre}$, with $c(m)$ being a correction factor for small sample sizes.[28] Positive values for d indicated a favorable change in the group from pretest to post-test, and vice versa. Effect sizes of 0.20, 0.50, and 0.80 refer to small, moderate, and large effect sizes, respectively.[29] Furthermore, one study compared two experimental conditions with the same control group so that the data from

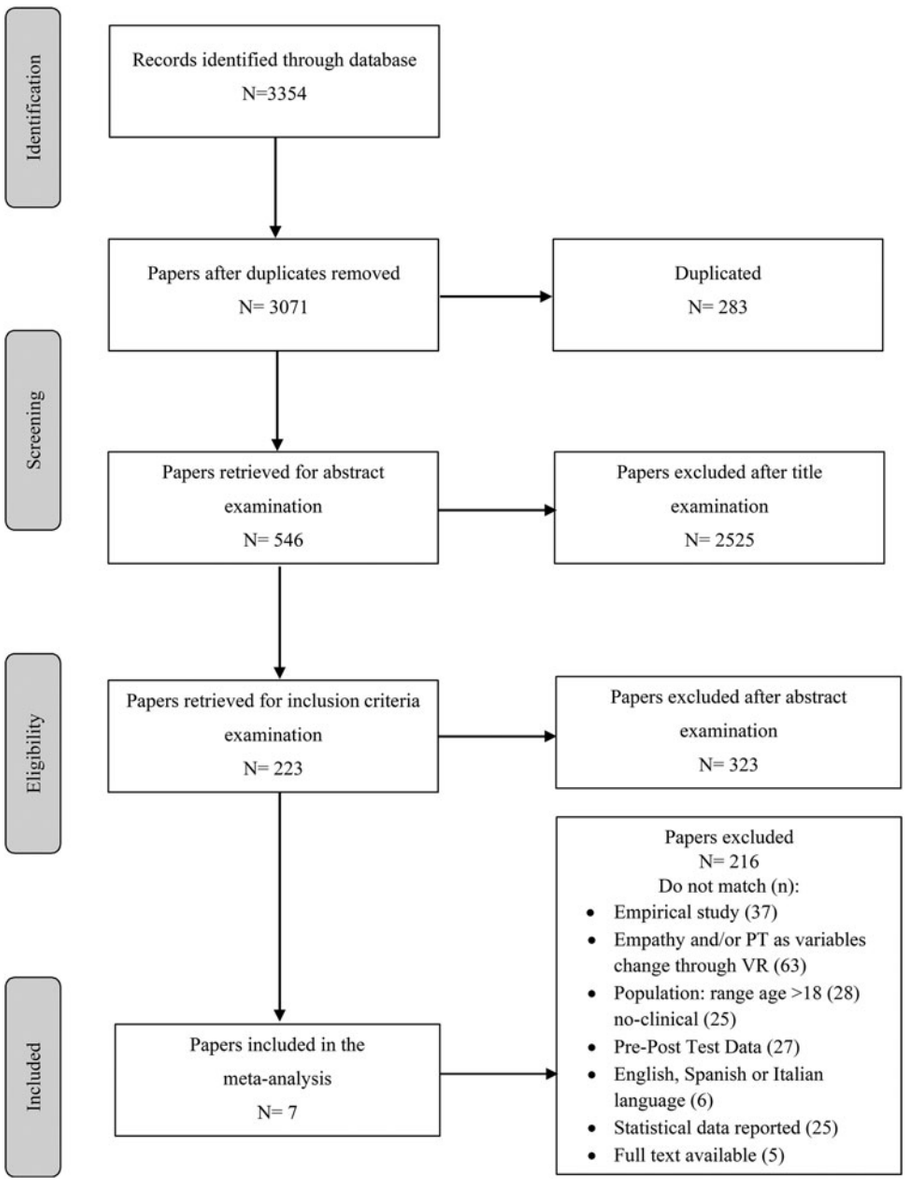

FIG. 1. PRISMA flow diagram: selection process of studies included in the meta-analysis. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

the control group were used twice in the effect size calculations.[30] To minimize the dependence produced by sharing the control group,[31] its sample size was divided in half.

To check the reliability of effect size calculations, two AU4 ▶ independent researchers (L.B.R. and L.G.) carried out the calculations for all of the studies, reaching an average intraclass correlation coefficient of 0.967 (range: from 0.869 to 1), which was also highly satisfactory.[32]

Statistical analyses

Separate meta-analyses were carried out with the effect sizes for two different outcomes: empathy and perspective AU5 ▶ taking. However, the individual studies did not necessarily include all the measures. For example, there were studies that only reported measures of empathy, but not of perspective taking, and so these studies contributed only to the corresponding meta-analyses. Therefore, each meta-analysis included a different number of studies, ranging from four to nine. In all cases, random-effects models were assumed in the statistical calculations. Random-effects models yield results that are identical to those of the fixed-effects model in the absence of heterogeneity and they allow conclusions to be generalized to a wider array of situations.[33,34] In each meta-analysis, a pooled standardized mean difference and its corresponding 95 percent confidence interval (CI) were calculated, and the statistical significance of the pooled standardized mean difference was assessed using the Z test. In addition, a forest plot was constructed to represent the individual and pooled effect size estimates, with their 95 percent CIs, and to allow visual inspection of study heterogeneity. Additionally, to assess the heterogeneity of effect sizes, both Cochran's Q statistic and the I^2 index were calculated.[35] A Q statistic with $p < 0.05$ was indicative of

heterogeneity among the effect sizes. The degree of this heterogeneity was estimated using the I^2 index. I^2 values of around 25 percent, 50 percent, and 75 percent denoted low, moderate, and large heterogeneity, respectively.[36] Finally, to assess publication bias, a funnel plot with Duval and Tweedie's trim and fill method for imputing missing data and the Egger test were used.[37,38] Funnel plots with Duval and Tweedie's trim and fill method use available data to impute missing (unreported) studies and recalculate the overall effect that would be observed with their inclusion.[37] The Egger test is an unweighted simple regression that takes the precision of each study as the independent variable (with precision being defined as the inverse of the standard error of each effect size) and the effect size divided by its standard error as the dependent variable. A nonstatistically significant result of the *t* test for the hypothesis of an intercept equal to zero means that publication bias can be ruled out as a threat to the validity of the pooled effect.[38]

Statistical analyses were performed with the Comprehensive Meta-Analysis software program, version 3.3.[39] All statistical tests were interpreted assuming a significance level of five percent ($p < 0.05$), using two-tailed tests.

Results

Study characteristics

Characteristics of the included studies are presented in Table 1. There were seven studies identified in the current review. They included a total of 335 participants, with a mean age of 31.7. Sample size of the included studies varied considerably, ranging from 16 participants[40] to 65 participants.[30]

The results of the critical appraisal of the selected studies are presented in Table 2. The average score obtained with the quality scale (range: 0–9) was 5 (minimum: 4 and maximum: 7). Only one study[30] used a control group, and in two studies, the participants were randomized.[30,41] In addition, three studies[42–44] did not report the reliability of the measurement instruments used. However, all studies met the following criteria: point estimate and variability, appropriate statistical analysis, and an acceptable dropout rate. Finally, none of the studies estimated the statistical power *a priori* or blinded the assessor.

General studies review

This section presents a brief description of the articles included in the meta-analysis, specifically the experience with VR, and the empathy measures adopted.

Adefila et al.[42] tested *myShoes*, a VR environment to experience living with dementia. The goal of the study was to improve awareness of dementia symptoms and empathy. Participants are asked to perform common daily tasks. The tasks incorporate misdirection as an approach to instill a sense of confusion. Fifty-five health care students tested the VR environment, and results showed significant differences in empathy ($p < 0.001$). Through the D'mentia Lens is another program[45] designed also to improve empathy toward the dementia disorder. It is a 360° movie where participants could experience, in first perspective, living with dementia. The 360° scenario reflected a normal day of someone in the early stage of Alzheimer's with the usual activity's limitations. The movie was accompanied by an inner voice that reflected the thoughts of the person. Thirty-five informal caregivers took part in the study and significant changes in empathy were found ($p < 0.002$). In a related study, Formosa et al.[41] tested a VR environment to improve empathy toward people with schizophrenic spectrum disorder. The VR environment was developed following the work ''Living with Voices: 50 Stories of Recovery.''[46] The stories showed how patients with schizophrenia perform some daily life activities. First, participants read a vignette describing the background of a person with a psychotic disorder. Then, participants were immersed into the VR simulation, where the person represented in the vignette is looking inside his/her house. Participants have to interact with the environmental objects and explore the virtual world. Fifty participants from the general public and undergraduate

Table 1. Study Characteristics

Study/location	n	*Age (mean)*	*Percent males*	*Technology*	*Sense of illusion*	*Empathy questionnaire*
Adefila et al. (2016)/UK[42]	55	NR	NR	Immersive VR	Presence	IRI
Bouchard et al. (2013)/ KVHF, Canada[43]	22	37	38	Immersive VR	Presence	Proper questionnaire
Bouchard et al. (2013)/ UVF, Canada[43]	20	37	38	Immersive VR	Presence	Proper questionnaire
Formosa et al. (2018)/ Australia[41]	50	34.60	44	Immersive VR	Presence	Proper questionnaire
Hamilton-Giachritsis et al. (2018)/Spain[44]	20	39.30	0	Immersive VR	Embodiment	AAPI-2
Raij et al. (2009)/USA[40]	16	NR	62.5	Immersive VR	Presence	Ad. JES
Van Loon et al. (2018)/ Direct Empathy, USA[30]	52	20.28	36.5	Immersive VR	Embodiment	IRI (PT and EC subscales)
Van Loon et al. (2018)/ Indirect Empathy, USA[30]	65	20.28	40	Immersive VR	Embodiment	IRI (PT and EC subscales)
Wijma et al. (2017)/ Netherlands[45]	35	55.10	23	Immersive VR	Presence	IRI (PT subscales)

AAPI-2, Adult-Adolescent Parenting Inventory-2 (Bavolek and Keene)[51]; Ad. JES, adaptation of the Jefferson Empathy Scale (Hojat et al.)[47]; IRI, Interpersonal Reactivity Index (Davis)[3]; NR, not reported; VR, virtual reality.

TABLE 2. METHODOLOGICAL QUALITY OF STUDIES INCLUDED

	Internal validity	*Random allocation*	*Sample size post-test*	*Blind assessors*	*Reliability of instruments*	*Acceptable dropout rate*	*Point estimates and variability*	*Statistical analysis appropriate*	*Statistical power*	*Total (0–9)*
Adefila et al. (2016)[42]	0	0	1	0	0	1	1	1	0	4
Bouchard et al. (2013)[43]	0	1	1	0	0	1	1	1	0	5
Formosa et al. (2018)[41]	0	0	1	0	1	1	1	1	0	5
Hamilton-Giachritsis et al. (2018)[44]	0	0	1	0	0	1	1	1	0	4
Raij at al. (2009)[40]	0	0	1	0	1	1	1	1	0	5
Van Loon et al. (2018)[30]	1	1	1	0	1	1	1	1	0	7
Wijma et al. (2017)[45]	0	0	1	0	1	1	1	1	0	5

psychology students were included. Results showed significant improvement in attitudes and empathetic understanding ($p < 0.001$) after the VR exposure. Empathy was measured through an *ad hoc* questionnaire. Raij et al.[40] developed the virtual social perspective-taking intervention where participants have to interview a virtual patient diagnosed with breast cancer, who expressed fear and pain. Sixteen medical students took part in the study. The scenario includes patient challenges that should prompt the students to express empathy. Empathy was measured through the adapted version of the Physician Empathy Scale[47]; results showed no significant change in empathy ($p = 0.227$) or perspective taking after the interaction with the virtual patient ($p = 0.778$). Bouchard et al.[43] studied the difference in empathy toward known (KVHF) and unknown (UVHF) persons represented by virtual humans who express pain during the VR exposure. Forty-two participants ($n = 22$ KVHF and $n = 20$ UVHF) were recruited. Empathy was measured through an *ad hoc* questionnaire. Results showed that participants felt more empathy toward the KVHF virtual human than the UVHF person ($p = 0.010$). ◀AU6

The studies described above are based on the sense of presence in VR,[48] where the participants took the perspective of the protagonist in VR, but they did not embody someone else. Van Loon et al.[30] adopted the embodiment paradigm to induce participants to have the illusion of being someone else[49] and compare two conditions: taking the perspective of the partner in the VR simulation (direct empathy, $n = 52$) and taking the perspective of a different person (indirect empathy, $n = 65$). In this study, first, participants were given few moments to generate the body transfer by performing a series of movements to associate their movements with the avatar's movements. Second, participants started to navigate into virtual scenarios, completing three tasks: a morning routine, speaking in front of the class, and working out at the gym. Undergraduate students took part in the study and used a tracker VR system to induce a high sense of immersion and interaction. The Perspective Taking and Empathic Concern subscales of the Interpersonal Reactivity Index[50] were applied. Results showed a higher score on perspective taking both for direct empathy ($p < 0.001$) and indirect empathy conditions ($p < 0.001$). In this line, Hamilton-Giachritsis et al.[44] adopted an embodied VR system to allow 20 mothers to embody a 4-year-old child. The goal was to help parents understand what it feels to be a child. Participants wore the OptiTrack suit to associate their movements with the avatar's movements. Then, in the VR environment, a virtual mother entered into the virtual scenario and started to talk with the child (the participant). The Adult–Adolescent Parenting Inventory-2 (AAPI-2)[51] was adopted to test empathy, and results showed a significant difference in empathy ($p < 0.001$).

Mean effect size and heterogeneity analysis

A separate meta-analysis was carried out for each outcome measure. Table 3 shows the main results for the two meta-analyses and Figures 2 and 3 present a forest plot for each of them. Overall, the two average effect sizes were positive, in favor of the treatments (Table 3). Furthermore, all the mean effect sizes had a small to moderate magnitude, according to Cohen's criterion,[29] because they were above or close to 0.50. ◀T3 ◀F2 ◀F3

Table 3. Mean Effect Size and Heterogeneity Analysis for the Two Outcome Measures

Outcome	K	d_+	95 percent CI		Q	df	p	I^2
			d_l	d_u				
Empathy	9	0.435	0.061	0.809	134.240	8	<0.001	94.04
Perspective taking	4	0.513	0.146	0.880	22.930	3	<0.001	86.92

k: number of studies. d_+: mean effect size. d_l and d_u: lower and upper confidence limits of the 95 percent CI around the mean effect size. *Q*: heterogeneity statistic. df: degrees of freedom. I^2: heterogeneity index.
CI, confidence interval.

Figure 2 presents a forest plot for empathy, with a mean effect size of $d_+ = 0.44$ (95 percent CI: 0.06–0.81), statistical significance ($p = 0.023$), and effect sizes that exhibited great variability ($I^2 = 94$ percent).

Figure 3 presents a forest plot for perspective taking, with a mean effect size of $d_+ = 0.51$ (95 percent CI: 0.15–0.88), statistical significance ($p = 0.006$), and effect sizes that exhibited moderate variability ($I^2 = 86.9$ percent).

Analyses of publication bias

Because all the included studies were published articles, analyses were carried out to determine whether publication bias might be a threat to the validity of results of the meta-analysis. The Duval and Tweedie[37] trim and fill method did not impute any effect size (Figs. 4, 5).

F5 ▶ F4 ▶

Additionally, the Egger test applied to the intercept of a simple regression model of effect sizes did not reach statistical significance [intercept = 6.224, $t(7) = 1.355$, $p = 0.218$, for the empathy outcome and intercept = –6.923, $t(2) = 1.069$, $p = 0.397$, for the perspective-taking outcome]. Therefore, publication bias can be reasonably ruled out as a serious threat to our meta-analytic findings.

Discussion

The purpose of the current meta-analysis was to determine whether VR could be an efficacious medium to elicit empathy. To our knowledge, it is the first study to use an analytic strategy to examine this question. Separate meta-analyses were carried out for effect sizes obtained from measures of empathy. An analysis of publication bias enabled us to rule it out as a threat to the validity of our results. The average score on the critical appraisal was 5 for all the studies included, which represents moderate quality, adding to the credibility of the conclusions. Our findings suggest that there were positive changes due to empathy interventions. Regarding empathy outcomes, the mean effect size was small to moderate and statistically significant ($d_+ = 0.44$). Regarding perspective taking, the mean effect size was moderate and statistically significant ($d_+ = 0.51$).

According to the articles included, VR was adopted to study empathy for two reasons. First, because VR allows creating environments that reflect the real one, participants inside the VR condition have the illusion of being in a real environment.[48] Second, thanks to VR, it is possible to create the laboratory control studies and, in some cases, overcome ethical limitations.[52]

Furthermore, from the current meta-analysis, two important concepts emerged from the VR field to elicit empathy: the sense of presence and embodiment. Previous researchers demonstrated that the sense of presence facilitates feelings of connection with others and accurately understanding others' perspectives.[53] This might occur because empathy and the sense of presence have common features[54,55] that include thoughts and feelings related to an imagined experience and the projection of the self into the experience of another person. Recently, the concept of the sense of presence has been broadened to include the sense of being present inside someone else's body (embodiment). VR has the ability to modify the perception of the body's boundaries, giving the illusion of being another person.[48] One of the studies included in the meta-analysis found that the sense of

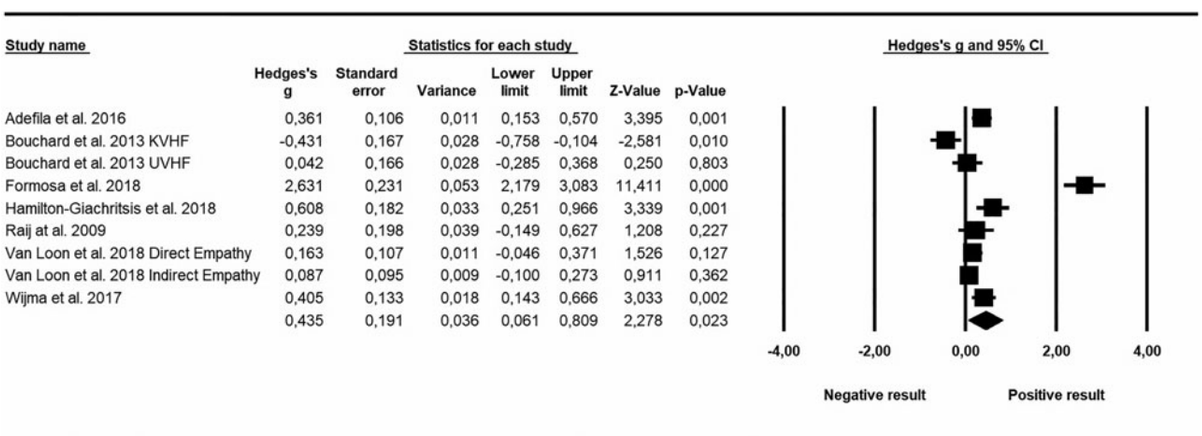

FIG. 2. Forest plot of the effect sizes for empathy. CI, confidence interval.

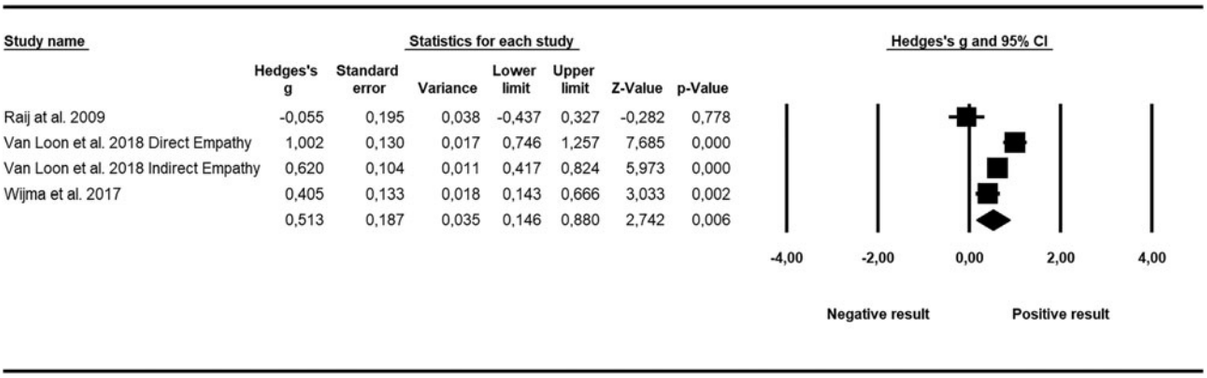

FIG. 3. Forest plot of the effect sizes for perspective taking.

embodiment could induce participants to virtually take the perspective of someone else, changing the emotional state,[30] thanks to the illusion that VR generates.[56]

The findings have practical implications for clinical psychology and other fields in which interpersonal relationships play a fundamental role. For instance, VR can be a powerful tool for training future health and social care practitioners, as well as other formal and informal caregivers, due to the fact that VR makes it possible to learn and train in a safe, practical, and cost-effective way.[41,42,45]

Limitations and future direction

The meta-analysis has several limitations. The main goal of the meta-analysis was to demonstrate the capability of VR to generate empathy, therefore even though there are more studies using VR for empathy, several studies were excluded given that they do not present empathy measures before and after the use of VR; this led to the inclusion of a low number of studies (also triggered by the fact that the field is in its early stages), which limited our ability to examine moderating variables. In addition, the absence of control groups in the primary studies forces the meta-analysis to use an effect size index with low internal validity, conditioning the scope of the results.

Future studies should use different measures of empathy, taking into account, for example, implicit measures. Another point to consider is investigating whether the results of the study last over time because no followup measurements were carried out in any of the studies. Moreover, five studies focused on the sense of presence, and two studies addressed the sense of embodiment (see Table 2 for details); however, no studies have investigated which one is better to elicit empathy. Furthermore, the studies adopted different immersive technologies such as the OptiTrack system[44] or the 360° video-based VR system[45] to induce the body swap illusion or

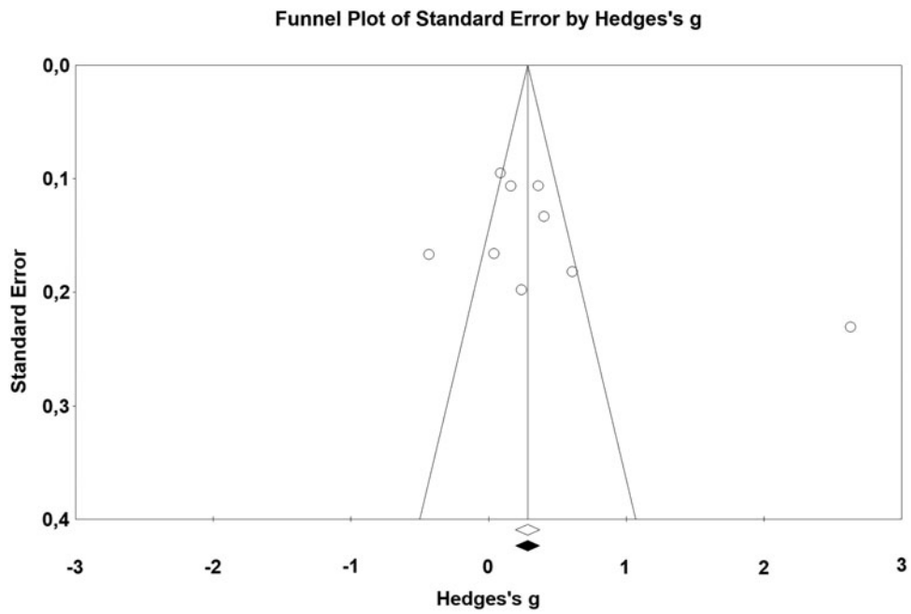

FIG. 4. Funnel plot of effect sizes for measures of empathy to assess publication bias. *White circles* represent each of the included studies.

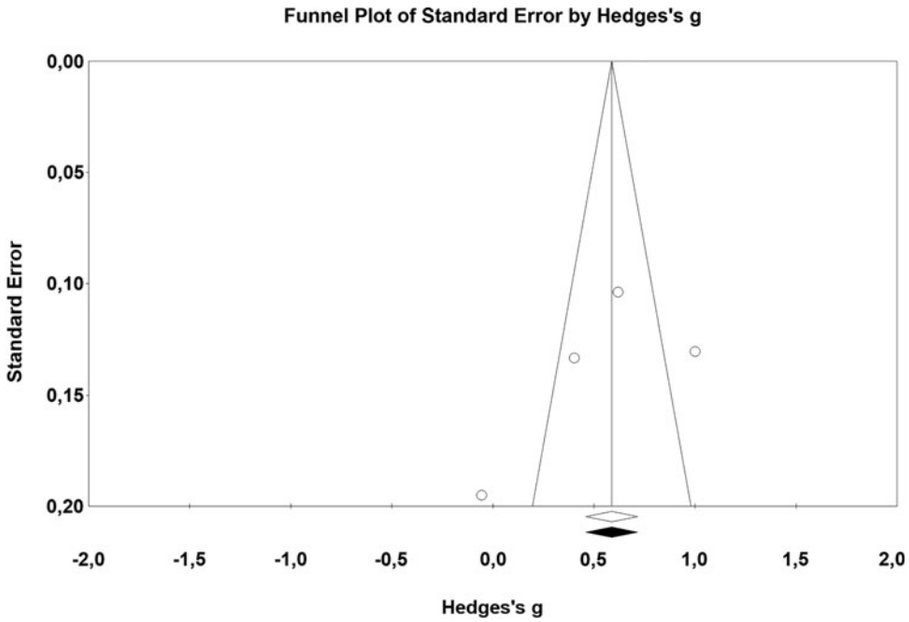

FIG. 5. Funnel plot of effect sizes for measures of perspective taking to assess publication bias. *White circles* represent each of the included studies.

for changing perspectives; future studies should investigate if the change in empathy variable is moderated by the technology used.

Despite these limitations, results of this study provide encouraging evidence supporting the use of VR to promote empathy toward outgroup members. Our study is the first meta-analysis on the effect of VR exposure on empathy, allowing a more accurate view of this phenomenon, although with the limitations described above.

Conclusions

Empathy is a key construct in social relationships and has been shown to be associated with prosocial behavior in previous research. VR is a medium that uses technology to get an individual to take the perspective of someone else. The current meta-analysis found higher scores on empathy and perspective taking after VR exposure.

Eliciting empathy through VR is a research field that is grown exponentially, and the results of the analysis provide evidence that VR tasks may be more effective at improving attitudes toward specific social targets and motivating prosocial behavior compared with traditional interventions adopted so far.

Author Disclosure Statement

No competing financial interests exist.

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