**ISSN 1577-7057**





Volume 23, number 1 March 1, 2023
Volumen 23, número 1 1 Marzo, 2023

ISSN: 1577-7057

# IJP&PT

## International Journal of Psychology & Psychological Therapy



https://www.ijpsy.com

## *IJP&PT* is included in the following indexing and documentation Centers

*International Journal of Psychology & Psychological Therapy*, 2023, *23*, 1, 31-41


# What if you could see yourself with my eyes? A Pilot Study of the Impact of a Virtual Reality-environment on Relational Responding to Self

**Essi Sairanen*, Daniel Wallsten**
*Karlstad University, Sweden*
**Dermot Barnes-Holmes**
*Ulster University, Northern Ireland*
**Maria Tillfors**
*Karlstad University, Sweden*

## Abstract

People's sense of self plays an important role in psychological wellbeing and it is often targeted by perspective taking interventions in psychological treatments. The present study investigated if seeing oneself from the outside perspective in a virtual reality (VR) environment could be used to influence the patterns of relational responding that constitutes the sense of self. Changes in participants' (*N*= 9) patterns of relating themselves vs. others with positive attributes and negative attributes were investigated using an Implicit Relational Assessment Procedure (IRAP) that was delivered before and after the one session perspective-taking intervention in VR. In addition, participants' self-ratings about their experience of the VR intervention were investigated immediately after and one month after the VR-intervention. The results showed changes specifically in seeing oneself more positively, reflected by the increase in the *Me – positive* trial type in the IRAP. No systematic changes were seen in participants' relational responding to themselves as being "negative" (i.e. bad, unloved, incompetent) or in patterns of relational responding considering others. In addition, participants experienced moderate positive emotions during the VR-intervention and evaluated the experience as meaningful based on their self-ratings. Together these results suggest that seeing oneself in the VR promoted positive experiences relating to oneself.
*Key words*: virtual reality; sense of self; relational frame theory; implicit relational assessment procedure.

**How to cite this paper**: Sairanen E, Wallsten D, Barnes-Holmes D, & Tillfors M (2023). What if you could see yourself with my eyes? A Pilot Study of the Impact of a Virtual Reality-environment on Relational Responding to Self. *International Journal of Psychology & Psychological Therapy, 23, 1,* 31-41.

### *Novelty and Relevance*

*What is already known about the topic?*

- Negative judgements about oneself are central in many psychological problems.
- Perspective taking interventions aim to modify people's relational responding to themselves.
- Some promising applications of Virtual Reality have been recognized in affecting the sense of self.

*What this paper adds?*

- This study investigated if seeing oneself from the outside perspective in a virtual reality environment could be used to influence the patterns of relational responding that constitutes the sense of self.
- Seeing oneself in the virtual reality positively influenced participants' relational responding to themselves as being good (e.g. lovable, competent).

People's sense of self plays an important role in psychological wellbeing and functioning. Negative judgements about oneself are central in many psychological problems (Glass, Merluzzi, Biever, & Larsen, 1982; Swallow & Kuiper, 1988). Thus, impacting people's often automatic and intuitive approach towards themselves has an important role in psychological treatments. Relational Frame Theory (RFT, Hayes,

* Correspondence: Essi Sairanen, Department of Social and Psychological Studies, Karlstad University, E-651 88 Karlstad, Sweden. E-mail: essi.sairanen@kau.se

Barnes-Holmes & Roche, 2001) offers a functional contextual account of the verbal processes that define a sense of self, which may enable us to analyze and influence a sense of self by identifying empirically testable units of analysis.

According to RFT, the core elements of human cognition are relational responding, that is, responding to events in certain ways based on their symbolic or verbal relationships to other events rather than their formal properties. This ability to engage in "arbitrarily applicable" relational responding (AARRing) appears to be key to the emergence of higher cognitive abilities such as planning, thinking, and the verbal construction of self (see Hayes, Barnes-Holmes, & Roche, 2001) for an in-depth account of RFT). The RFT definition of self relies on three core deictic or perspective taking relations: the distinction between I-YOU, the spatial distinction between HERE-THERE, and the temporal distinction between NOW-THEN (Barnes-Holmes, 2001). The core postulation here is that as children learn to respond in accordance with these relations, they are in essence learning to verbally derive themselves through distinguishing self from others, now from there, and here from there; "I am here and now" (Barnes-Holmes, Hayes, & Dymond, 2002; McHugh, Barnes-Holmes, & Barnes-Holmes, 2004).It has been argued that once a verbal self is established in the behavioral repertoire of an individual, it becomes an ongoing behavioral event that participates in virtually every relational response or psychological event. When humans navigate their psychological worlds, I is being related to different qualities such as male or female, good or bad, valuable or worthless, and so on. Throughout life, a complex story (i.e., relational networks) about who 'I' am, with more or less self-critical elements develops. As such, a person responds to every stimulus/event from the constant perspective of a verbal self (deictic-I), regulated by the current and historical contexts.

Perspective taking interventions, often applied in psychological treatments, aim to modify people's relational responding to themselves. Through perspective taking, a person can mentally observe oneself from different perspectives, shifting between *me-here-now* and *me-there-now/then* perspectives. For example, observing oneself from the perspective of a loving friend can be used to evoke more self-compassionate responses. Psychological qualities that are part of the friendship (e.g., love, care, compassion) 'become present' to the experience where one is observing oneself. In other words, specific functions may be transferred and transformed via relating the two relational networks of 'a friend connecting with me' and 'me connecting with myself'.

In the present study, instead of imagining another person's perspective, participants are allowed to see a filmed representation of themselves in a virtual reality (VR) environment. This "new perspective" to oneself, could possibly be used to impact a person's relational responding about oneself. Some promising applications of VR have been recognized in affecting the sense of self, but unlike the present study, previous studies have used an avatar of oneself. For example, VR techniques added to standard cognitive behavior therapy helped to improve body image (Cesa *et alia*, 2013; Marco, Perpina, & Botella, 2013; Riva, Bacchetta, Cesa, Conti, & Molinari, 2003). In another study, participants interacted compassionately with a crying virtual child while embodied in a virtual adult body, after which they were embodied in the child virtual body, aiming to provide a situation enabling participants to deliver compassionate sentiments and statements to themselves. This resulted in a greater increase in self-compassion compared to a control condition in which participants saw the same gestures and heard the same words but from a non-embodied, third-person perspective (Falconer *et alia*, 2014). However, to our knowledge, the current study is the first that investigates participants

seeing a "real" representation of themselves in VR and thus, could suggest the new implication of using VR in clinical settings.

Relational responding concerning self may be relatively fast and brief and thus it may be useful to employ measures that are designed to capture such behavior. Accordingly, the present study employs a performance-based measure, called the Implicit Relational Assessment Procedure (IRAP). This measure appears to capture brief and immediate relational responses that may reflect person's learning history (Barnes-Holmes, Barnes-Holmes, Stewart, & Boles, 2010). The IRAP is a latency-based measure, in that participants must confirm or deny a specific relation between a label stimulus and a target term (e.g., Me= Good; True or False?). The computer-based task requires participants to respond quickly and accurately in ways that are deemed to be either consistent or inconsistent with their prior learning histories. For example, across a large number of trials, participants should, due to their history of responding, generally be faster to respond that "happy" and "glad" are "similar" than that "happy" and "glad" are "different. Similarly, we could determine if participants will be faster to respond that "me"= "good" is "true" than "me"= "good" is "false". The key point is that the relative ease (i.e. speed) with which individuals can relate "me" being "good" as "true" or "false" may reveal an individual's history of relating these stimuli, and therefore the likelihood that they will respond similarly in the future.

Importantly, brief relational responses appear to be predictive of clinically relevant future behaviors, such as onset or relapse (Steinberg, Karpinski, & Alloy, 2007), response to treatment (Carpenter, Martinez, Vadhan, Barnes-Holmes, & Nunes, 2012), and suicide attempts (Nock *et alia*, 2010). In addition, brief and immediate relational responses are malleable. For example, Hooper, Villatte, Neofotistou, and McHugh (2010) found that performance on an IRAP that targeted acceptance or suppression of unwanted thoughts could be altered using a mindful breathing exercise versus a thought-suppression intervention. Thus, clinical research should also focus on the malleability of brief and immediate relational responding within therapeutic settings.

In the present study, we used an IRAP to investigate if seeing oneself from an outside perspective in a Virtual Reality (VR) environment could be used to influence the patterns of relational responding that constitutes a sense of self. Changes in participants' patterns of relating themselves vs. others with positive attributes and negative attributes were investigated from pre to post the perspective-taking intervention in VR. In addition to investigating changes in brief and immediate relational responding, participants' self-ratings about their experience of the perspective taking intervention in VR were investigated.

## Method

### *Participants*

To participate in the study participants had to be 18 years old or older. Participants were excluded if they had a psychiatric diagnosis that impaired their everyday functioning, limited eyesight not corrected by contact lenses, or did not speak fluent Swedish.

The sample consisted of 9 participants, 6 females and 3 males. The mean age of participants was 39.2±9.7 years (range 21-55). All participants were married or in a relationship, but two of them were not living together with a partner. All except one had children living at home. Five participants had university level education and four

had a post-secondary level education. Six were in permanent employment, two were students and one unemployed.

### *Design*

The data from two slightly different VR interventions (described in detail below) were combined for the present study, investigating changes on a group-level from pre- to post-VR-intervention. Two studies were originally planned as separate sub-studies applying a single-case design. Consequently, participants completed the IRAP several times; 1-3 times before the VR-intervention (one IRAP/day), immediately after the VR-intervention and once a day after the intervention. However, only the IRAP data collected immediately before (i.e., pre-IRAP measure) and after (i.e., post-IRAP measure) the VR-intervention were analyzed within this study. The effects from these immediate pre- to post-IRAP measures were assumed to be due to the VR-intervention specifically. Instead, the IRAP measures conducted on other days could be affected by different variables and there was no stable baseline observed over the several pre-IRAP measures.

### *Measures*

*Implicit Relational Assessment Procedure* (IRAP). The IRAP was used to measure the patterns of relational responding to self. Participants' patterns of relating themselves vs. others with positive attributes (e.g., good, valuable; i.e., *Me – positive*) and negative attributes (e.g., bad, useless; *Me – negative*) were measured. Face pictures (12 pictures taken at the lab-visit) of the participants were used to present oneself as a label stimulus. A label stimulus for others were presented by 12 generic face pictures that were matched by the gender and age of the participant. The target stimuli were positive and negative attributes (e.g., good-bad, likable-disgusting, see Table 1). Accordingly, the four trial-types were denoted as: *Me – positive; Other – positive; Me – negative;* and *Other – negative*. Trials were presented in two opposite types of blocks; A, *Me* has positive attributes and *Othe*r has negative attributes (i.e., Self-positive) and B, *Me* has negative attributes and *Other* has positive attributes (i.e., Self-negative). The required correct and incorrect response options for each trial-type in each of the two blocks were pre-determined by the task structure itself (see Table 1). For example, a *Me – positive* trial in a Self-positive block might present the participant with the stimuli "Picture of self" and "likable" and the response options "True" and "False". In this case, True would be the correct response, by definition, while selecting False would present the participant with a red X indicating a wrong answer. However, if these same stimuli appeared on a self-negative block (B) trial, the correct response would now be False. The IRAP is arranged in this way in order to assess the difference in reaction times between self-positive (A) and self-negative (B) blocks for each trial-type (e.g., the difference in speed between responding True on self-positive blocks vs. False on self-negative blocks). It is assumed that this difference indicates which response pattern is consistent with the participants' learning histories (Hughes & Barnes-Holmes, 2013).

*Table 1.* Consistent Answers to Self-positive and Self-negative blocks for the Four Different Trial-types in the IRAP and positive and negative attributes used as target stimuli.

| | Trial-type 1<br>*Me – positive* | Trial-type 2<br>*Me – negative* | Trial-type 3<br>*Others – positive* | Trial-type 4<br>*Others – negative* |
|---|---|---|---|---|
| Answer consistently with Self-positive block | "true" | "false" | "false" | "true" |
| Answer consistently with Self-negative block | "false" | "true" | "true" | "false" |
| Positive attributes | successful, smart, good, whole, good-looking, capable, beloved, valuable, appreciated, stable, competent, secure | | | |
| Negative attributes | unsuccessful, stupid, bad, broken, ugly, helpless, unloved, useless, undesirable, unstable, incompetent, insecure | | | |

*Self-ratings*. A visual analog scale (VAS) was used to rate an experience about the VR-intervention immediately after completing it. The following questions were asked: 1. The strength of the feelings produced by the VR-intervention? (very weak – very strong), 2. How negative/positive were the feelings aroused during the intervention? (very negative–very positive), 3. How meaningful was the experience you had during the VR intervention? (very meaningless–very meaningful).
A follow-up survey was used to rate the VR-intervention one month after completing it. The following questions were asked: 1. How meaningful was the experience you had during the VR intervention? (0= very meaningless, 10= very meaningful), 2. Do you feel that the VR-intervention has affected you in a way that you can notice today? (0= not at all, 10= very much so; If so, how?), 3. Would you be interested in meeting yourself again in a VR environment if you had the opportunity? (Not at all/I don't think so/ Probably/Absolutely).

### *Procedure*

The current study was approved by the Ethical Review Board at Uppsala University in Sweden (Dnr 2019-06213).

Participants were recruited through Karlstad University's web page and Facebook page. A total of 30 individuals informed their interest in the study by signing an electronic consent form and filling out a screening survey. 14 participants were invited to participate in the study from which 3 participants dropped out before the first laboratory visit. One participant dropped out after the first IRAP measure and one participant was excluded from the analyses for not performing the pre-IRAP measure according to set accuracy criteria, resulting in a final sample of 9 participants.

Laboratory visits were conducted individually. On a laboratory visit, at first, participants completed the pre-IRAP measure. The IRAP presented label (face pictures) and target stimuli (positive and negative attributes) on a computer screen and required a participant to respond in accordance with the current block. If a participant answered inconsistently with the block type a red "X" appeared on the screen and the participant had to answer consistently with the block type to continue to the next trial. The IRAP presented a minimum of two and a maximum of six practice blocks, followed by six test blocks. Each block presented 48 trials. Participants had to meet a criterion of 80% accuracy and a median latency under 2000 milliseconds in each practice block, in order to advance to the test blocks.

The pre-IRAP measure was followed by the VR-intervention. At first, all participants were filmed with a 3D-camera while they sat on a chair for 3 minutes. Participants were advised to keep natural eye contact with the camera lens. Second, the participant watched the recording for 10 minutes, by using a VR-headset. The recorded sequence was looped. The participant was seated in a chair on the opposite side of where they sat during recording, to create a sense of sitting opposite to themselves. Neutral background music was played during recording and playback in order to block out background noise. For 3 participants (IDs 7-9) recorded prompts were played while they watched themselves. Prompts are presented in Table 2. In effect, two slightly different versions of the VR-intervention were used (1. VR-intervention without prompts, $n$= 6; 2. VR-intervention with prompts, $n$= 3).

After the VR-intervention participants were asked to rate their experience by using the VAS-scales and complete the post-IRAP measure (similar to the pre-IRAP measure). An online follow-up survey was completed one month after the laboratory visit. 8 participants answered the follow-up survey.

*Table 2*. Prompts Used in the VR-intervention with prompts.

| Time passed | Instruction |
|---|---|
| 30 sec into recording | "You will soon hear some instructions. While sitting here, see if you can get in touch with something that you are struggling with and that you carry on the inside, as a human being" |
| 30 sec into playback | "A question will soon follow. What is the person in front of you carrying on the inside, what is the person in front of you struggling with, as a human being?" |
| Three min into playback | "You will soon hear a new question. How are you feeling about the person in front of you?" |
| Six min into playback | "You will soon hear a new question. What do you think has shaped the person in front of you?" |
| Nine min into playback | "And finally, what does the person in front of you need of you?" |

### *Data Analysis*

Trial types *Me – positive, Me – negative, Others – positive* and *Others – negative* were analyzed independently in terms of the difference in response latencies between responding that is deemed consistent (coherent) versus inconsistent (incoherent) with a participant's verbal history (AARRing) and transformed into $D_{IRAP}$ scores, a measure of effect size (Hughes & Barnes-Holmes, 2011). In other words, $D_{IRAP}$ scores were calculated through the time difference in response latency (divided by the standard deviation of the mean reaction time) between answering self-positive/others-negative versus self-negative/others-positive. For clarity of interpretation *Others – positive* and *Others – negative* trial-types were inverted (i.e., multiplied by –1), so that *D* scores greater than zero on different trial-types all indicate a positive bias. Thus, $D_{IRAP}$ scores above zero indicate "Me/Others positive and not-negative effects", whereas $D_{IRAP}$ scores below zero indicate "Me/Others negative and not-positive effects" (see Table 3). Related samples Wilcoxon signed rank test was used to analyze within group changes. Effect sizes were calculated by using the formula $r = z/\sqrt{N}$ (Rosenthal, Cooper, & Hedges, 1994).

*Table 3*. Interpretation of $D_{IRAP}$ Scores for each trial-type.

| | Trial-type | | | |
|---|---|---|---|---|
| | *Me – positive* | *Me – negative* | *Others – positive* | *Others – negative* |
| $D_{IRAP}$ scores above 0 | Pressed "true" faster than "false" | Pressed "false" faster than "true" | Pressed "true" faster than "false" | Pressed "false" faster than "true" |
| | I am [positive word] | I am not [negative word] | Others are [positive word] | Others are not [negative word] |
| $D_{IRAP}$ scores below 0 | Pressed "false" faster than "true" | Pressed "true" faster than "false" | Pressed "false" faster than "true" | Pressed "true" faster than "false" |
| | I am not [positive word] | I am [negative word] | Others are not [positive word] | Others are [negative word] |

*Note*: Trial-types Others – positive and Others – negative have been inverted for clarity of interpretation.

## RESULTS

All participants met a criterion of 80% accuracy and a median latency under 2000 milliseconds in each test block.

Changes from pre to post VR-intervention in *Me – positive, Me – negative, Others – positive* and *Others – negative* $D_{IRAP}$ scores for each participant are presented in Figure 1. Systematic changes were seen only in *Me – positive* $D_{IRAP}$ scores. *Me – positive* increased for 7 participants and decreased for 2 participants. Both participants

with decreased *Me – positive* $D_{IRAP}$ score had a $D_{IRAP}$ score above zero in both pre- and post-measurements, reflecting more positive responding to oneself to begin with. Wilcoxon signed rank test (see Table 4) showed that on average, there was a significant change from pre ($M$= 0.10, $SD$= 0.47) to post ($M$= 0.43, $SD$= 0.20) for the *Me – positive* trial type ($p$= .033), representing a large-sized effect, $r$= 0.71.

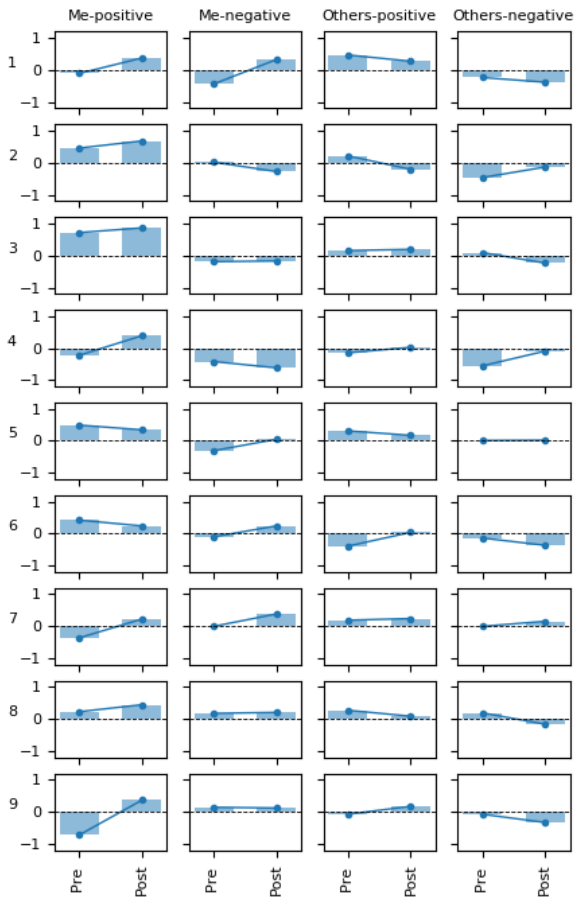


Figure 1. Changes in *Me – positive, Me – negative, Others – positive* and *Others – negative* $D_{IRAP}$ scores. (*Note*: Participants 1-6 received VR-intervention without prompts and participants 7-9 received VR-intervention with prompts.

No systematic changes were seen in *Me – negative* or *Others – positive* and *Others – negative* $D_{IRAP}$ scores. The results of paired sample t-tests of $D_{IRAP}$ scores for each trial-type are presented in Table 4.

In order to see if the simple repetition of the task induced changes by itself, we conducted related-samples Wilcoxon signed rank tests for the $D$-scores of the different trial types upon repeated exposure to the task before the VR-intervention (i.e., from the first IRAP to the second IRAP for those participants who repeated the IRAP at least

once before the VR-intervention, $n$= 7). No significant changes were seen in any $D_{IRAP}$ scores from the first pre-measurement to the second pre-measurement ($p$-values >.05).

*Table 4.* Means, Standard Deviations and results Wilcoxon signed rank test of $D_{IRAP}$ Scores for each trial-type.

| Trial type | Pre | | Post | | Z | *p* | *r* |
|---|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | | | |
| *Me – positive* | .099 | .471 | .433 | .203 | -2.134 | .033 | 0.71 |
| *Me – negative* | -.124 | .231 | .029 | .325 | -1.362 | .173 | 0.45 |
| *Others – positive* | .110 | .262 | .110 | .146 | -0.059 | .953 | 0.02 |
| *Others – negative* | .130 | .248 | -.169 | .182 | -0.415 | .678 | 0.14 |

*Note*: $r = z/\sqrt{N}$; 0.1 - < 0.3 (small effect), 0.3 – < 0.5 (moderate effect), ≥ 0.5 (large effect) (Rosenthal *et alia*, 1994).

The participants rated their experience about the VR-intervention right after completing it by using visual analog scales (VAS) and again in the 1-month follow-up. VASs were re-scaled so that the answer options vary from 0 to 10. Means, standard deviations and range of the ratings are presented in Table 5. Overall, participants experienced moderate positive emotions during the VR-intervention and evaluated the experience as quite meaningful both right after and at the follow-up. Only one participant (ID 7) reported experiencing negative instead of positive emotions during the VR intervention (i.e., making a mark to the left/"negative" side on a VAS). In the follow-up, participants were also asked if they would be interested in meeting oneself again in a VR environment if they had the opportunity. Five participants answered "Absolutely", two participants "Probably" and one "I don't think so".

*Table 5.* Self-rated experiences of the VR-intervention.

| Post-VR items ($n$= 9) | *M* | *SD* | Range |
|---|---|---|---|
| How strong feelings the VR-intervention evoke? (very weak – very strong) | 6.6 | 1.2 | 4.5-8.3 |
| How negative/ positive were the evoked feelings during the intervention? (very negative – very positive) | 6.6 | 1.5 | 3.4-8.5 |
| How meaningful was the experience you had during the VR-intervention? (totally meaningless – very meaningful) | 7.4 | 1.2 | 5.2-8.9 |
| Follow-up items ($n$= 8) | | | |
| How meaningful was the experience you had during the VR-intervention? (totally meaningless – very meaningful) | 7 | 2.8 | 1-10 |
| Do you feel that the VR-intervention has affected you in a way that you can notice today? (not at all – very much so) | 4.4 | 3.4 | 1-10 |

## DISCUSSION

The present study investigated if seeing oneself from the outside perspective in a VR environment could be used to influence the patterns of relational responding that constitutes the sense of self. Changes in participants' patterns of relating themselves vs. others with positive attributes (e.g., good, valuable) and negative attributes (e.g., bad, undesirable) were investigated using an IRAP that was delivered before and after a self-related VR-intervention. In addition, participants' self-ratings about their experience of the VR-intervention were investigated.

The results yielded some potential for the perspective taking intervention in VR to impact the sense of self. Participants relational responding to themselves as being "positive" (i.e., good, beloved, competent) increased from pre to post VR-intervention, reflected by the increase in $D_{IRAP}$ score of the *Me – positive* trial type. This is a clinically interesting finding since previous research has shown that brief relational responses are

highly predictive of clinically relevant future behaviors (Carpenter *et alia*, 2012; Nock *et alia*, 2010; Steinberg *et alia*, 2007) and that they can be modified (Hooper *et alia*, 2010).

Our results showed changes specifically in seeing oneself in a more positive manner suggesting that the VR-intervention may have impacted upon the self in a relatively precise way. No systematic changes were seen in participants' relational responding to themselves as being "negative" (i.e. bad, undesirable, incompetent) or in patterns of relational responding considering others from pre to post VR-intervention. These results make sense considering the nature of the present intervention. The VR-intervention targeted an experience of oneself (by seeing oneself from the outside perspective), and not directly an experience about others. In addition, when interpreting the present findings, it is important to notice that relational responding to oneself as positive may be functionally different from responding to oneself as negative. For example, in some contexts, an individual might relate to oneself as being appreciated and loved and in another context as insufficient and incapable, and both experiences could be equally "true" for the individual.

It is also important to note that participants experienced moderate positive emotions during the VR-intervention and evaluated the experience as meaningful based on their self-ratings immediately after and one month after the VR-intervention. These self-rated experiences appear to be generally consistent with the changes in the *Me – positive* trial-type. Both observations suggest that seeing oneself in the VR promoted positive experiences relating to oneself. Perhaps, the VR experience did not, therefore, impact the *Me-Negative* trial-type, because the experience was generally positive rather than negative. In future studies, it would be interesting to investigate if the *Me – negative* trial-type could be targeted by prompting it more directly before or during the VR-session. Also, it is important to notice that the present study was conducted with a non-clinical sample and that different results might have been seen with participants who suffer from psychological problems or a significantly negative sense of self.

The current study was not designed to test a recent conceptual development in the IRAP literature; specifically, the Differential Arbitrarily Applicable Relational Responding Effects (DAARRE) model and the Hyper-Dimensional, Multi-Level (HDML) framework (see, Barnes-Holmes & Harte, 2022) for a detailed treatment of these concepts). As such, no reference was made to the model or framework in the introduction, and it would not be appropriate to make any strong post-hoc claims with respect to these developments in the context of the current research findings. Nevertheless, it may be worth noting that, according to the DAARRE model, the largest changes occurred for the type of trial that, theoretically, may be seen as the most coherent during blocks that required an affirmative (Yes) response; specifically, the *Me – positive* trial-type for non-clinical participants, where Me and positive both have positive functions, and where True would also be positive and be a relatively strong indicator of relational coherence. If this trial-type did indeed yield the highest level of coherence among the four trial-types, it is interesting that it also appeared to be the trial-type that was most sensitive to the VR-intervention. Further post-hoc speculation would be unwise, of course, but it may be useful for future research to explore this potential differential trial-type VR-sensitivity effect.

Moreover, the findings should be taken in the context of the following limitations. The sample size was small and there was no control group. Accordingly, we cannot be sure if the changes in the *Me - Positive* trial-type were due to the VR-intervention. However, the fact that the VR-intervention increased the effect only for the self-positive

trial-type suggests that the increase may not have been due to some generic increase in IRAP effects when participants are re-exposed to the procedure. In addition, no significant changes were seen from the first IRAP to the second IRAP before the VR-intervention. However, similar studies with a control group are warranted.

Other limitations were that two slightly different versions of the VR-intervention (with and without prompts) were analysed together in statistical tests and that participants conducted different numbers of the pre-intervention IRAPs that could have affected their performance. All three participants receiving prompts in the VR-intervention showed increased *Me – positive* $D_{IRAP}$ scores, whereas 4/6 participants showed this effect in the VR-intervention without prompts. However, two participants receiving prompts had highly negative *Me – positive* $D_{IRAP}$ score in pre-measure leaving more room for improvement. In future, the VR-intervention with more elaborated prompts guiding participants' orientation might be worth studying as well as conducting studies with participants suffering from psychological problems.

To sum up, the present pilot study suggests that seeing oneself from an outside perspective in a VR environment could be used to positively influence participants' relational responding to themselves as being good (valuable, beloved) within a non-clinical population. This is a clinically interesting finding considering that brief relational responses are predictive of clinically relevant outcomes (Carpenter *et alia*, 2012; Nock et alia, 2010; Steinberg *et alia*, 2007) and that the sense of self plays an important role in many psychological problems (e.g., Swallow & Kuiper, 1988).

## References

Barnes-Holmes D, Barnes-Holmes Y, Stewart I, & Boles S (2010). A sketch of the Implicit Relational Assessment Procedure (IRAP) and the Relational Elaboration and Coherence (REC) model. *The Psychological Record*, 60, 527-542. DOI: 10.1007/BF03395726

Barnes-Holmes D, Hayes SC, & Dymond S (2002). Self and self-directed rules Relational frame theory. In D Barnes-Holmes & B Roche (Eds), *Relational Frame Theory: A post-Skinnerian account of human language and cognition* (pp. 119-139). Boston, MA: Springer.

Barnes-Holmes Y (2001). *Analysing relational frames: Studying language and cognition in young children*. Unpublished Doctoral dissertation, National University of Ireland, Maynooth.

Barnes-Holmes D & Harte C (2022). Relational frame theory 20 years on: The Odysseus voyage and beyond. *Journal of the Experimental Analysis of Behavior, 117*, 240-266. DOI: 10.1002/jeab.733

Carpenter KM, Martinez D, Vadhan NP, Barnes-Holmes D, & Nunes EV (2012). Measures of attentional bias and relational responding are associated with behavioral treatment outcome for cocaine dependence. *The American Journal of Drug and Alcohol Abuse, 38*, 146-154. DOI: 10.3109/00952990.2011.643986

Cesa GL, Manzoni GM, Bacchetta M, Castelnuovo G, Conti S, Gaggioli A, Mantovani F, Molinari E, Cárdenas-López G, & Riva G (2013). Virtual reality for enhancing the cognitive behavioral treatment of obesity with binge eating disorder: randomized controlled study with one-year follow-up. *Journal of Medical Internet Research, 15*, e113. DOI: 10.2196/jmir.2441

Falconer CJ, Slater M, Rovira A., King JA, Gilbert P, Antley A, & Brewin CR (2014). Embodying compassion: a virtual reality paradigm for overcoming excessive self-criticism. *PloS one, 9*, e111933. DOI: 10.1371/journal.pone.0111933

Glass CR, Merluzzi TV, Biever JL, & Larsen KH (1982). Cognitive assessment of social anxiety: Development and validation of a self-statement questionnaire. *Cognitive Therapy and Research, 6*, 37-55. DOI: 10.1007/BF01185725

Hayes SC, Barnes-Holmes D, & Roche B (2001). *Relational Frame Theory: A Post-Skinnerian Account of Human Language and Cognition*. New York: Guilford Press.

Hooper N, Villatte M, Neofotistou E, & McHugh L (2010). The effects of mindfulness versus thought suppression on implicit and explicit measures of experiential avoidance. *International Journal of Behavioral Consultation*

*and Therapy, 6*, 233-244. DOI: 10.1037/h0100910

Hughes S & Barnes-Holmes D (2011). On the formation and persistence of implicit attitudes: New evidence from the Implicit Relational Assessment Procedure (IRAP). *The Psychological Record, 61*, 391-410. DOI: 10.1007/BF03395768

Hughes SJ & Barnes-Holmes D (2013). A functional approach to the study of implicit cognition: The IRAP and the REC model. In B Roche & S Dymond (Eds.), *Advances in Relational Frame Theory & Contextual Behavioural Sscience: Research & Applications* (pp. 97-126). Context Press.

Marco JH, Perpina C, & Botella C (2013). Effectiveness of cognitive behavioral therapy supported by virtual reality in the treatment of body image in eating disorders: one year follow-up. *Psychiatry Research, 209*, 619-625. DOI: 10.1016/j.psychres.2013.02.023

McHugh L, Barnes-Holmes Y, & Barnes-Holmes D (2004). Perspective-taking as relational responding: A developmental profile. *The Psychological Record, 54*, 115-144. DOI: 10.1007/BF03395465

Nock MK, Park JM, Finn CT, Deliberto TL, Dour HJ, & Banaji MR (2010). Measuring the suicidal mind: Implicit cognition predicts suicidal behavior. *Psychological Science, 21*, 511-517. DOI: 10.1177/0956797610364762

Riva G, Bacchetta M, Cesa G, Conti S, & Molinari E (2003). Six-month follow-up of in-patient experiential cognitive therapy for binge eating disorders. *Cyberpsychology & Behavior, 6*, 251-258. DOI: 10.1089/109493103322011533

Rosenthal R, Cooper H, & Hedges L (1994). Parametric measures of effect size. In H Cooper & L Hedges, *The Handbook of Research Synthesis*, (pp. 231-244). New York: Russell Sage Foundation.

Steinberg JA, Karpinski A, & Alloy LB (2007). The exploration of implicit aspects of self-esteem in vulnerability–stress models of depression. *Self and Identity, 6*, 101-117. DOI: 10.1080/15298860601118884

Swallow SR & Kuiper NA (1988). Social comparison and negative self-evaluations: An application to depression. *Clinical Psychology Review, 8*, 55-76. DOI: 10.1016/0272-7358(88)90049-9

Received, February 8, 2022
Final Acceptance, November 15, 2022