# Virtual Reality as a Tool for Promoting Reading via Enhanced Narrative Absorption and Empathy

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**Abstract**

Reading fiction is beneficial for various social skills, although reading has become less and less popular with younger generations. This study investigated whether reading a chapter of a fictional story in virtual reality (VR) can make the reading experience more appealing and increase intention to read the story further. A between-subject experiment ($n$ = 83) was conducted to compare the effect of a printed book and a VR reading environment on narrative absorption, empathy with fictional characters, and intention to read. The results show that VR enhances intention to read, via a serial mediation of transportation into the story world and affective empathy. These findings indicate that VR can be effectively exploited for promoting reading.

*Keywords*: reading; virtual reality; narrative absorption; empathy; transportation; fiction.

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Reading fiction is not merely entertainment, but an activity through which skills crucial for a well-functioning society are exercised and developed. For example, reading fiction is associated with increased social cognition (Dodell-Feder & Tamir, 2018; Mumper & Gerrig, 2017), empathy (Mar et al., 2009; Mar & Oatley, 2008), and egalitarian attitudes (Fong et al., 2013), however this latter also depends on the content of the reading. However, reading of fiction declines dramatically after childhood and young people prefer to engage in other kind of entertainment activities, such as watching online videos or playing video games: teenagers like stories but reading for leisure is most probably less attractive than audiovisual and interactive narratives (Chin Ee & Baoqi, 2018; Clark & Teravainen, 2017; Feierabend et al., 2018; cf. Johnsson-Smaragdi & Jönsson, 2006; Peters & van Strien, 2018; Wennekers et al., 2016). To capitalize the benefits of literature, tools and strategies that effectively promote reading and increase intention to read need to be developed.

The driving idea of the present study is that accessing literature via virtual reality (VR) can make reading more appealing. Virtual reality is a medium able to convey extremely immersive fictional experiences that are perceived as non-mediated by technology (see Bailenson, 2018). Previous research has already shown that VR environments increase attention and sense of presence in users (Baños et al. 2004), and can elicit emotional arousal (Diemer et al., 2015; Riva et al., 2007). However, these effects have never been capitalized on promoting reading and, thus, there is no research about reading fiction in VR. There have been attempts to make books a more "contemporary" medium by exploiting the tools offered by computers and other digital media. The results are works that go under the names of "digital fiction" (Bell et al., 2010), "electronic literature" (Hayles, 2008), or "multimodal stories" (Ryan, 2015). However, empirical research about how digital fiction is experienced is scarce (Bell et al., 2018) and the media specific nature of the experience is still unclear. Moreover, so far, there are only a few studies investigating how media format differently affects readers' and viewers' experiences, mostly comparing film and literature (Bálint et al., 2017; Green et al., 2008).

To address this research gap, the present study examines how VR influences the reading experience, focusing on two often researched concepts related to reading fiction, narrative absorption (Kuijpers et al., 2014) and empathy with the characters (Burke et al., 2016). Narrative absorption is an experiential state that can emerge while reading a fictional narrative text, viewing an audiovisual fictional narrative, or using an interactive narrative artefact, like video games. Narrative absorption, a concept closely related to "transportation" (Green et al., 2004), "narrative engagement" (Busselle & Bilandzic, 2009), and "identification" (Tal-Or & Cohen, 2010), is characterized by heightened sense of focused attention, transportation into the fictional world, emotional engagement with characters, and activated mental imagery (Kuijpers et al., 2014). Empathy can be defined as a process by which we understand and share (real and fictional) other's mental states (Burke et al., 2016; Shen, 2010). Both narrative absorption and empathy correlate with enjoyment (Busselle & Bilandzic, 2009; B. K. Johnson & Rosenbaum, 2015; Krakowiak & Oliver, 2012; Tal-Or & Cohen, 2010), thus it is reasonable to assume that increased levels of narrative absorption and empathy will elicit higher intention to read, since people will perceive reading fiction as an enjoyable activity. To test this assumption, we conducted an experiment in which participants read a story either printed on paper or presented in a virtual reality book.

The ways in which the VR medium could affect reading, absorption, and empathy are various: for instance, through visual and sound effects emphasizing specific narrative moments (as in films), animated illustrations, virtual agents (characters) that move in the 3D space, representation of the story setting, diegetic typesetting and user interface (as in some video games; Whalen, 2008), etc. However, before exploring all these dynamic possibilities it is sensible to test solutions that depart from traditional experiences of reading only to a limited extent. That is, for the sake of experimental control we investigated the impact of a static virtual

reading setting (see Figure 2), in which the virtual reality environment serves as a background setting for the reading as opposed to playing an interactive role during reading.

## Literature and virtual reality

In the history of electronic literature there are some examples of reading experiences designed for VR, either reproducing the book format in a virtual 3D space (*Andromedum*, 2016; Wales, 2016) or adopting a typesetting that is more freely integrated with the 3D world (*Aphiddd*, 2019; Pasieka, 2017). The main rationale behind these multimodal projects is to leverage the *immersion* offered by the VR medium (Ryan, 2015). Despite the growing interest for applications of VR in liberal arts education and its introduction into public libraries (Radianti et al., 2020), there is no research on the use of VR for reading fiction.
With respect to narrative, there are not many studies on how the reading environment affects the aesthetic experience of reading (exceptions are Allington, 2011; Burke, 2011; Burke & Bon, 2018; Fialho et al., 2011), let alone narrative absorption. Marie-Laure Ryan (2015) suggested that in location-based narratives – i.e. stories whose progression is bound to the reader's physical movements in a specific place – the presence of the referent could intensify the audience's experience, since emotional and spatial immersion are combined. Accordingly, stories in which landscape and setting are more relevant (e.g. *Lord of the Rings*) would benefit from the representation of the narrative world in VR, since it would intensify spatial immersion.
A more articulated theoretical proposal has been advanced by Kuzmičová (2016), who maintains that the reading environment can be a distractor, a prop for imagery, and a locus of pleasure, possibly affecting narrative absorption. Although auditory perception may be a more effective form of environmental propping, due to the attention to the text required for reading, vision is also an important factor since readers often purposefully choose the environment in which to read (Burke & Bon, 2018). Sometimes readers also pause briefly when reading and their gaze roams around the place. During these moments the visual perception of the environment interferes with the imagination and emotions elicited by the story, either reinforcing or contrasting them. With respect to this, it has been shown that VR environments congruent with the activity performed affect users' attention and performance differently than neutral images (Neumann & Moffitt, 2018; Schmidt et al., 2018). In other words, the VR space can function as a reading setting that isolates the reader from the distractions of the physical world (such as mobile phone notifications, people passing by, etc.), which can help the reader get more involved in the activity of reading, leading to a higher level of narrative absorption.

## Narrative absorption

The multidimensional concept of narrative absorption – as theorized and measured by Kuijpers et al. with the *Story World Absorption Scale* (SWAS) (2014) – is suitable to distinguish readers' response to the narrative and to the media environment, since it has been specifically developed for understanding the different facets of reading experiences. Both narrative theory (Ryan, 2015) and empirical research (Kuijpers et al., 2014) showed that immersion/absorption is multidimensional inasmuch as it relates to at least three different aspects of narrative: setting (spatial immersion/ transportation into the story world), plot (temporal immersion/ attention), and characters (emotional immersion/ emotional engagement).

In the following subsections we discuss how the subdimensions of narrative absorption (i.e. attentional focus, transportation, emotional engagement, mental imagery) are relevant for VR experiences, and the concepts and measures that are used to understand immersive non-textual media experiences.

**Attentional focus.** The subdimension of attentional focus refers to a sense of sustained focus kept on what is happening in the story, often leading readers to decreased self-perception and awareness of their surroundings. It is a feeling of deep concentration which is perceived as effortless (Kuijpers et al., 2014). As mentioned earlier, VR is a potential tool to facilitate attentional focus by effectively excluding external distractions. In case of print reading these distractions have to be ignored by a conscious effort of the reader. Relatedly, it has been shown that cognitive training in VR can enhance attention more than computer-based training, helping to develop longer attention span (Cho, Ku, et al., 2002), also in cases of attention deficit hyperactivity disorder (Cho, Lee, et al., 2002). Therefore, it is reasonable to assume that VR compared to print reading enhances attentional focus by excluding potentially distracting inputs from the outside world.

**Transportation.** Originally, transportation has been defined as a holistic construct, "a convergent process, where all mental systems and capacities become focused on events occurring in the narrative" (Green & Brock, 2000, p. 701). Following Kuijpers et al.'s taxonomy (2014), transportation refers to the sense of deictic shift from the real world to the story world, that is the sensation of stepping into the fictional world during reading a narrative. During this process the reader does not lose contact with the actual world but there is a partial psychological relocation of the reader into the story world.

There is no previous research available on whether VR increases transportation while reading a fictional narrative, however related research on presence makes the assumption reasonable. Presence (Lombard et al., 2015; Lombard & Ditton, 1997) is defined as the perception of a non-mediated experience in VR, in other words it refers to the extent to which people feel physically present in the VR environment. Over the years, the concept has been widely debated and there are now different theorizations, both including and excluding the use of a technological medium (Riva et al., 2015; Skarbez et al., 2017, 2017). Previous studies and available measures suggest that VR can increase people's sense of presence in the virtual environment (Hartmann et al., 2016; Lessiter et al., 2001; Lombard et al., 2009; Vorderer et al., 2004; Witmer & Singer, 1998). However, these studies mainly focused on presence in the displayed environment, therefore the concept of presence can be hardly used to directly measure the sense of being transported into the fictional world created by written stories (see section "Outlook and future research" below). VR environments elicit presence more than other media (Cummings & Bailenson, 2016): seeing a world different from the one in which the reader's body is located prompt a deictic shift into the VR world, which could facilitate a further shift into the story world, thus eliciting transportation. Therefore, this study aims to answer the question whether a VR-presented story can increase readers' transportation more than a printed story.

**Emotional engagement.** The subdimension of emotional engagement is closely related to empathy (Burke et al., 2016; Shen, 2010) but it has a narrower scope, referring to the relation readers have with characters: the state of having "feelings *for* or *with* characters, such as sympathy, and empathy, and identification" (Kuijpers et al., 2014, p. 93). Higher emotional engagement leads to higher overall narrative absorption. Cohen's (2001) term of identification is similar to emotional engagement inasmuch as it is a process in which someone experiences a merge of identity with the character of a story. As emotional engagement with characters was shown to be a crucial component of literary experiences, the current study also included a more nuanced measure of readers' empathy with characters.

VR was shown to be more effective than other media formats in influencing empathy as a trait, i.e. eliciting a behaviour or attitude change related to empathic feelings (Archer & Finger, 2018; Herrera et al., 2018; Martignano et al., 2019; Schutte & Stilinović, 2017; van Loon et al., 2018). Furthermore, VR has been proved to increase a person's matching of emotions to that of another subject (Martignano et al., 2019). Based on these, it is reasonable to assume that VR can increase emotional engagement with the fictional characters.

**Mental imagery.** The subdimension of mental imagery refers to the process of visualising setting, characters, and situations while reading a story (Kuijpers et al., 2014). It is a concept specifically related to textual narratives, rather than audiovisual ones. There is a difference in the imaginative processes elicited by the two kinds of media: textual narratives prompt readers to imagine what is presented to them through written words, whereas audiovisual narratives do not require readers to imagine how the setting or a character look like. Kuzmičová (2014) has developed a refined theory of mental imagery prompted by narrative, distinguishing between four types of imagery, either related to the story world (referential) or to the effects elicited by verbal expression, both of which can be perceived from a stance inside or outside the story world. However, mental imagery has been theorized as a dimension of narrative absorption by Kuijpers et al. (2014) only as "referential imagery", in Kuzmičová's terms, that is with respect to the story world, without considering possible differences between inner and outer stance. On the one hand, it is hard to find textual narratives that are written entirely from an inner or outer stance, while on the other hand, the scale developed by Kuijpers et al. focuses only on absorption prompted by the story world. Regardless of the possible nuances, our study explores whether a VR environment that presents the text as the primary stimulus of narrative experience – thus enabling self-generated imagery – but also offers visual stimuli related to the story can elicit stronger mental imagery than printed books. This may be especially helpful for individuals who do not have high mental imagery ability (Green et al., 2008). The present study aims to answer whether VR can increase mental imagery.

For the reasons outlined above, we formulated the following hypotheses and research questions. VR-presented fictional narrative increases narrative absorption (H1) compared to fictional narrative presented in a printed book format. It is predicted that VR compared to printed book format increases levels of attention (H1.1) and emotional engagement (H1.2). Research question 1: Can VR-presented fictional narrative increase readers' transportation (RQ1.1) and mental imagery (RQ1.2) more than printed fictional narrative?

## Empathy

Empathy refers to the cognitive and emotional response to another person/ agent (Batson, 2009), often associated with character identification (Cohen, 2001; Mar et al., 2011). Empathy is a multidimensional concept, consisting of emotional and cognitive components. A useful distinction of the different dimensions of empathy as a state has been proposed by Shen (2010), who distinguishes between *affective empathy* (i.e. sharing someone else's feelings), *cognitive empathy* (i.e. understanding the perspective of another), and *associative empathy* (i.e. identification with the story message and characters). This latter component shows a strong similarity to the term identification as conceptualized by Tal-Or and Cohen (2010). Importantly, these authors showed that absorption and identification with characters are two separate but related concepts constituting the narrative experience.

Empathy can occur with VR (Schutte & Stilinović, 2017) and other narrative formats (Shen, 2010). With respect to narrative texts, task-oriented measures (Kidd & Castano, 2013; Mar et al., 2009) or qualitative methods (Kuzmičová et al., 2017) have been mostly employed to

understand the effect of reading on empathy. Previous research found that empathic experiences are dependent on narrative absorption: being more absorbed into the story led to greater affective empathy towards characters (D. R. Johnson, 2012).

Previous studies showed that VR can have an effect on empathy. A recent meta-analysis (Martignano et al., 2019) found that VR has a positive effect on affective empathy (here defined as sharing emotions with and feeling empathic concern for an observed other) (Cohen's $d = .33$), but not on cognitive empathy. This means that VR experiences can make it easier for people to feel affective empathy for an observed other, but do not improve cognitive empathy. Previous research has mainly focused on how the immersive simulation of perspective-taking can affect empathy (Herrera et al., 2018; van Loon et al., 2018). Only a few studies considered affective empathy for virtual agents, finding that VR increases the extent to which people care about the wellbeing of a virtual agent (Schutte & Stilinović, 2017). Schutte and Stilinović (2017) also found that the effect of VR on empathy is mediated by participants' focused attention (in their terminology "engagement"). However, the knowledge is still limited on the kind or technological features that contribute to the effect of VR on empathy: the meta-analysis (Martignano et al., 2019) showed no effect of interactive or immersive qualities (e.g. spatialized sound or realistic visuals) on empathy. Furthermore, a recent meta-analysis has shown that literary fiction can significantly increase empathy (and other social cognition skills) in readers (Mumper & Gerrig, 2017).

Given the attested effect of VR on empathy, the following hypothesis was formulated: VR-presented fictional narrative compared to fictional narrative presented in a printed book format increases empathy (H2), in particular affective empathy (H2.1). It was also predicted that there will be no difference between VR and printed book stories in terms of cognitive empathy (H2.2).

**Intention to read**

People prefer to do activities they enjoy. Previous studies have shown that enjoyment is a component of the intrinsic motivation that drives people to act (Cox & Guthrie, 2001; Touré-Tillery & Fishbach, 2014) and plays a role in motivation to read (Baker & Scher, 2002). This can be alternatively formulated as intention to continue the enjoyed activity. More generally, VR is a medium that increases enjoyment and motivation to engage in various activities, including learning (Cheng, 2017; Schmidt et al., 2018; Wei et al., 2019). This makes it reasonable to assume that VR may directly increase intention to read. Enjoyment has been proved to be associated with empathetic engagement with characters, and with narrative absorption (see Busselle & Bilandzic, 2017; Green et al., 2004; Tal-Or & Cohen, 2010). This suggests that absorption and empathy might mediate the direct effect of VR on intention to read. However, the available data is limited to formulate specific hypothesis.

For these reasons and given the relationship between narrative absorption and empathy described above, the following hypothesis and research question were formulated: VR-presented fictional narrative compared to fictional narrative presented in a printed book format increases intention to read (H3). Research question 2: Is the effect of VR-presented fictional narrative on intention to read mediated through narrative absorption and empathy with the characters (RQ2)?

To summarize, it can be assumed that VR has a high potential to increase narrative absorption and empathy through its various technological features influencing the components of these immersive experiences. When readers wear the head mounted display, they are more isolated from the outside physical word, which enables them to be less distracted, focus more and, in turn, invest higher level of cognitive capacity into the VR world and the read material. This increased cognitive investment can lead to higher emotional engagement and also to an

intensified mental imagery. VR has the power to elicit a non-mediated experience and the sensation of spatial presence in the VR environment. This increased spatial presence fosters the reader's shift from the physical world to the VR world, and this shift may further facilitate the shift into the story world. It can be assumed that transportation into the story world facilitates sharing emotions with the literary characters. VR can also provide visuals related to the story, which can inspire self-generated mental imagery further. Figure 1 presents the summary of hypotheses and research questions.

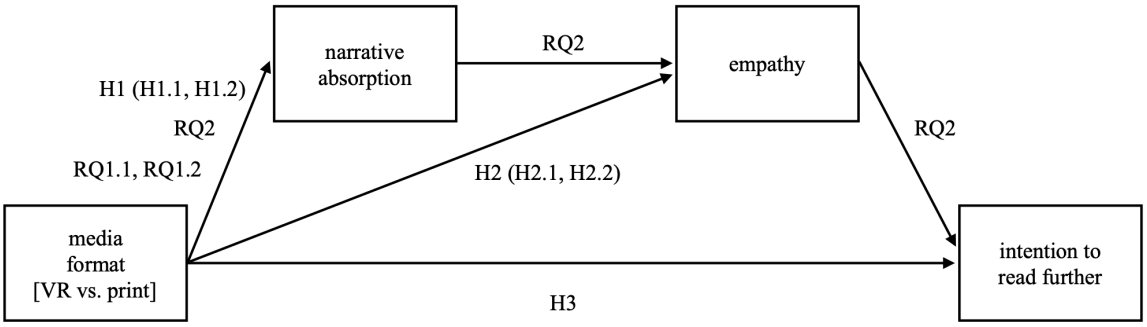


**Figure 1**. Visual conceptual model with hypotheses and research questions. Arrows express predicted effects.

**Individual differences**

According to previous research, individual differences in readers can affect the aesthetic experience of reading fiction: transportability, i.e. the individual tendency to feel absorbed in a narrative (Mazzocco et al., 2010), gender (Oliver et al. 2012), reading frequency (Kidd & Castano, 2013), and story familiarity are all variables that should be taken into account in order to eliminate potential noise in the statistical analysis, since they are likely to influence absorption and empathy (Dal Cin et al., 2004; Kidd & Castano, 2019; Mar et al., 2009). In the current study we control for these variables.

## Methods

### Design

To test the hypotheses, we conducted a one-factorial between-subject experiment. Participants were randomly assigned to either the printed or the VR version of a literary text. Dependent variables were narrative absorption, state empathy, and intention to read. Control variables were transportability, reading habits, familiarity with the story, technology acceptance, and familiarity with VR. Moreover, we wanted to control for the possible novelty effect of using VR, since using an immersive technology for the first time could affect the aesthetic experience – positively, for the sense of awe induced; negatively, if the participants happen to suffer motion sickness.

### Participants

Participants ($n$ = 83, 50 women, 42 in VR condition) were recruited via the Human Subject Pool of Tilburg University School of Humanities, in the Netherlands. Thirty-five of them have

completed their high school graduation, 41 their Bachelor, and 7 their Master. Age ranged from 18 to 34 years old ($M$ = 23.11, $SD$ = 3.68). Regarding reading frequency, 10.8% of the participants reported that they never read fiction, 42.2% rarely read fiction, 24.1 % occasionally read fiction, 13.3% often read fiction, and 9.6% read fiction very often. Participants chose the preferred language of the text, 29 participants read the story in Dutch and 54 in English. One participant did not communicate their gender and age and another participant did not communicate their age.

## Research stimuli

The first chapter of the book *Alice's Adventures in Wonderland* by Lewis Carroll (1865; 1947) was presented in two media formats: a printed version on paper, and a VR prototype (see Figure 2).


**Figure 2**. Interface of the VR environment designed for reading

The VR version was created using the open source web XR framework A-Frame (Marcos et al., 2017). It consists of a virtual environment allowing 3 degrees-of-freedom movements, i.e. only pitch (left and right), yaw (up and down), and roll of the head. The background was a 360° picture of an autumn park with trees, a bench, and a pathway. The text was divided into paragraphs, which were displayed on white opaque quadrilateral panels arranged in a linear sequence from left to right, orthogonal to the reader's point of view. Once they finished reading the text in front of them, the participants could move to the next paragraph by gazing at it, and the panel would then move in front of the reader. An interactive demonstration of the VR prototype, accessible via web browser, can be found in Pianzola (2018).

The printed version was designed for this study with a softcover (Figure 3). Pages were typeset and structured to resemble the VR format as much as possible. Each page presented a paragraph each, like the panels in the VR version. Therefore, the ecological validity of the study was assured by using both a text condition that is typical in a book reading situation and a typeset that allowed a reading progression (the "turning" of pages) which was comparable in both media formats.

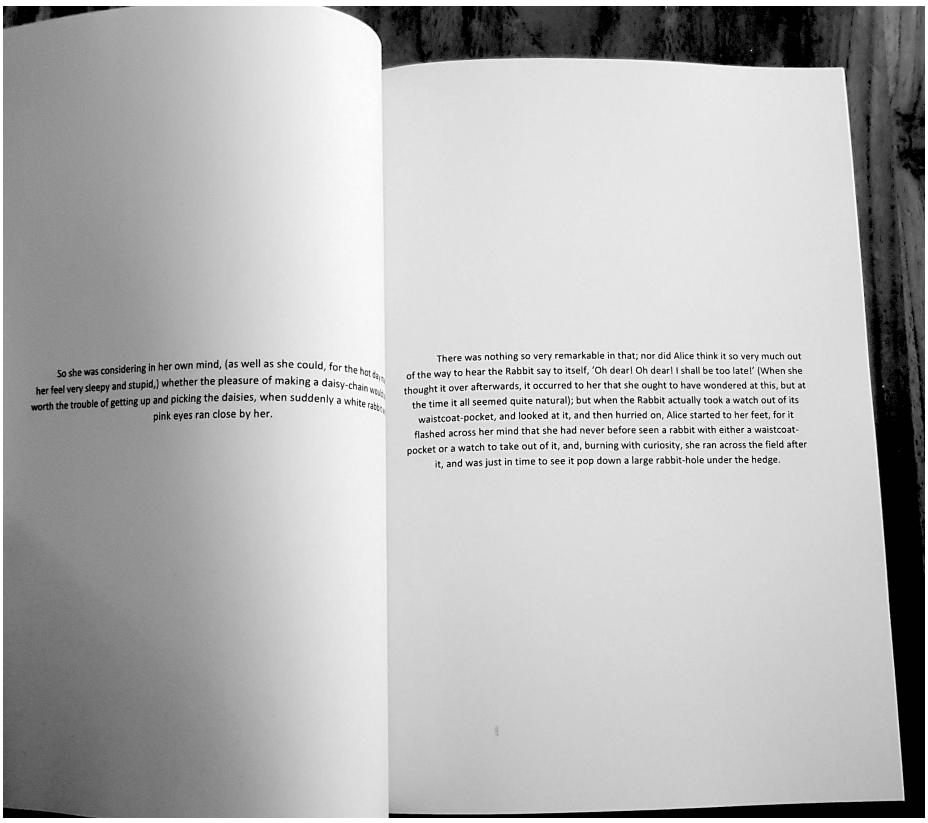


**Figure 3**. Booklet used to test the print condition

## Procedure

The experiment was conducted in an individual laboratory setting at Tilburg University. Participants were randomly assigned to one of the two conditions. Before starting the actual session, participants of the VR condition had a short preparatory trial with another VR scene to ensure that they felt comfortable wearing the head mounted display and did not experience any discomfort with the technology. If the participant decided to proceed, the actual testing session started. Participants sat on a swivel chair that allowed them to move freely and explore the environment in the VR condition. Participants accessed the VR version via a Fove head mounted display connected to an Asus ROG Strix GL702ZC laptop, using the Supermedium VR browser (Marcos et al., 2018). For the print condition, the booklet was provided on a table. For both conditions, participants could take as much time for reading as necessary or wanted. The average duration of sessions in both conditions was approximately 30 minutes. After the session, participants were instructed to fill an online survey accessed on a laptop. Before experimental sessions, participants signed an informed consent. Participants received course credits for their participation. Approval for the study was obtained from Tilburg University's Research Ethics and Data Management Committee.

## Measures

**Narrative absorption.** The extent to which readers felt absorbed in the story world was measured by the 18-item 7-point Story World Absorption Scale (SWAS) ($\alpha = .94$) (Kuijpers et

al., 2014). The scale comprises four dimensions: *attention* refers to being deeply concentrated without perceiving this action as effortful (e.g., "When I finished the story I was surprised to see that time had gone by so fast") (α = .81); *transportation* describes the subjective feeling of entering a story world (e.g. "When I was reading the story it sometimes seemed as if I were in the story world too") (α = .83); *emotional engagement* refers to the degree of feeling empathy or sympathy for a story character (e.g. "I felt sympathy for the main character") (α = .86); *mental imagery* describes the visualizations one creates in her/his own mind while reading (e.g. "I could imagine what the world in which the story took place looked like") (α = .86).

**State Empathy.** The 12-item 5-point State Empathy Scale was used to measure participants' empathic feelings towards the characters in the narrative (α = .91) (Shen, 2010). The scale encompasses three dimensions: *affective empathy* refers to understanding and sharing someone else's feelings (e.g. "I can feel the character's emotions") (α = .84); *cognitive empathy* involves perspective taking ("I recognize the character's situation") (α = .75); *associative empathy* refers to identification with the story message and characters ("When reading the story, I was fully absorbed.") (α = .81).

**Intention to read further.** To measure participants' intention to read *Alice's Adventures in Wonderland* further, a 5-item scale was generated for this study, e.g. "If I had the time, I would read the story of *Alice's Adventures in Wonderland* further". Agreement was indicated on a 7-point scale ranging from 1 "Strongly disagree" to 7 "Strongly agree" (α = .94).

**Controls.** To measure the individual tendency to be transported into a narrative, the Transportability Scale was used (Dal Cin et al., 2004). Additionally, one item (i.e. "How often do you read fiction, for example short stories or novels?") was used to measure reading frequency, with options ranging from 1 "Never" to 5 "Very often". Another item ("Were you familiar with the story of *Alice's Adventures in Wonderland* before this study?") assessed familiarity with the story, with options ranging from 1 "Not at all familiar" to 5 "Extremely familiar". One item (i.e. "Have you used the technology of virtual reality already before this experiment?") with a 7-point Likert scale ranging from 1 "Never" to 7 "More than five times" was employed to measure a participants' familiarity with VR technology. Gender, age and education level were also reported. In order to assess the extent to which participants of the VR condition perceived the technology as useful and easy to use, nine items derived from the Technology Acceptance Model 2 (TAM2) were used (α = .92) (Venkatesh & Davis, 2000).

An alpha level of .05 and type III sum of squares were used for all statistical tests. Mediation hypotheses were tested using univariate ordinary least squares (OLS) path analysis with IBM SPSS 26 and the PROCESS package version 3 (Hayes, 2018).

## Results[1]

### Preliminary checks

Normal distribution was found for narrative absorption, state empathy, the SWAS transportation subscale, affective and associative empathy, as well as transportability, and technology acceptance (Shapiro-Wilk Test, $p > .05$). All other variables showed non-normal distribution ($p < .05$). Therefore, in all analyses we corrected biases using accelerated bootstrapping at a confidence interval level of 95% with 5000 samples.

The two experimental groups did not differ significantly in the distribution of reading frequency ($t(81) = -1.59$, $p = .12$, BCa 95% CI [–0.862, 0.094), transportability ($t(81) = -1.70$, ,

[1] Data are openly available in (Pianzola, Weller, and Bálint 2019).

$p$ = .10, BCa 95% CI [–0.535, 0.034]), familiarity with the story ($t$(81) = 1.07, $p$ = .29, BCa 95% CI [–0.801, 0.220]), age ($t$(79) = 0.87, $p$ = .38, BCa 95% CI [–0.819, 2.233]), education level ($t$(81) = 0.99, $p$ = .33, BCa 95% CI [–0.137, 0.415]), and gender ($\chi^2$(1, $n$ = 81) = 0.05, $p$ = .82). Therefore, the assumption of independence between the independent variable and possible covariates is met, and the randomization was successful. We also tested the homogeneity of variance-covariance and the homogeneity of regression slopes, checking the interactions between the independent variable and the covariates. According to the results of two separate MANCOVAs – one with intention to read, narrative absorption, empathy; and one with intention to read and the subdimensions of absorption and empathy – the assumptions are met in all cases, except for the heterogeneity of "familiarity with the story" and "mental imagery" regressions slopes. Consequently, in the mentioned case, it would not be recommended to include the covariate in the analysis of covariance, but a Potthoff analysis (Potthoff, 1964) showed that there was no significant interaction between media format and familiarity with the story in influencing mental imagery ($F$(2, 79) = 1.66, $p$ = 0.20), therefore it could be included as a covariate.

Regarding gender, there was no significant difference between women and men with respect to narrative absorption (women: $M$ = 4.75, $SD$ = 0.83; men: $M$ = 4.50, $SD$ = 1.14, $t$(80) = –1.15, $p$ = .28, BCa 95% CI [–0.716, 0.213]) and its subscales, state empathy (women: $M$ = 3.17, $SD$ = 0.67; men: $M$ = 3.12, $SD$ = 0.70, $t$(80) = –0.29, , $p$ = .77, BCa 95% CI [–0.370, 0.275]) and its subscales, and intention to read (women: $M$ = 4.70, $SD$ = 1.40; men: $M$ = 4.02, $SD$ = 1.66, $t$(80) = –2.01, , $p$ = .055, BCa 95% CI [–1.360, 0.012]). However, since the $p$ value for intention to read was close to the threshold of significance, it might have been that, after controlling for other variables, gender was indeed associated with intention to read. Table 1 shows the differences between the two genders and the two media formats for all variables' mean scores. Within the group assigned to the VR condition, there was a significant difference between women and men with respect to familiarity with VR (women: $M$ = 2.92, $SD$ = 2.55; men: $M$ = 4.76, $SD$ = 2.68, $t$(39) = –2.01, $M_{diff}$ = 1.85, $SE$ = .84, $p$ = .03, BCa 95% CI [0.169, 3.471]), but not with respect to technology acceptance (women: $M$ = 4.38, $SD$ = 1.42; men: $M$ = 4.16, $SD$ = 1.35, $t$(39) = –0.50, $M_{diff}$ = –0.22, $SE$ = .43, $p$ = .60, BCa 95% CI [–1.034, 0.641]).

**Table 1.** Means and standard deviations for all variables for VR and print. Data for women, men, and total groups.

| | VR (SD) | | | Print (SD) | | |
|---|---|---|---|---|---|---|
| | Women | Men | Total | Women | Men | Total |
| 1. Intention to read | 5.31 (1.37) | 4.16 (1.60) | 4.85 (1.56) | 4.18 (1.26) | 3.86 (1.75) | 4.06 (1.46) |
| 2. Narrative absorption | 5.02 (.91) | 4.54 (1.40) | 4.83 (1.14) | 4.58 (0.82) | 4.46 (0.82) | 4.53 (0.81) |
| 3. Attention | 4.98 (1.16) | 4.50 (1.64) | 4.79 (1.38) | 4.54 (0.98) | 4.50 (0.99) | 4.53 (0.98) |
| 4. Transportation | 4.19 (1.19) | 3.85 (1.59) | 4.05 (1.36) | 3.58 (1.12) | 2.86 (0.88) | 3.30 (1.10) |
| 5. Emotional engagement | 5.08 (1.06) | 4.61 (1.50) | 4.89 (1.26) | 4.54 (1.17) | 4.76 (0.98) | 4.63 (1.09) |
| 6. Mental imagery | 5.83 (0.93) | 5.21 (1.44) | 5.58 (1.18) | 5.64 (0.90) | 5.71 (1.19) | 5.67 (1.01) |
| 7. Empathy | 3.47 (0.66) | 3.18 (.92) | 3.35 (0.78) | 2.94 (0.68) | 3.06 (0.39) | 2.99 (0.58) |
| 8. Affective empathy | 3.28 (0.80) | 2.90 (.99) | 3.12 (0.89) | 2.74 (0.53) | 2.81 (0.71) | 2.77 (0.60) |
| 9. Cognitive empathy | 3.76 (0.50) | 3.56 (.99) | 3.68 (0.73) | 3.35 (0.83) | 3.42 (0.57) | 3.38 (0.74) |
| 10. Associative empathy | 3.36 (0.87) | 3.09 (1.00) | 3.25 (0.92) | 2.73 (0.88) | 2.94 (0.53) | 2.81 (0.76) |
| 11. Transportability | 5.03 (0.64) | 5.02 (.74) | 5.03 (0.67) | 4.79 (0.65) | 4.76 (0.68) | 4.78 (0.65) |
| 12. Reading frequency | 3.04 (1.21) | 2.65 (1.11) | 2.88 (1.17) | 2.64 (1.07) | 2.25 (1.06) | 2.49 (1.07) |
| 13. Familiarity with the story | 3.76 (1.05) | 2.76 (1.39) | 3.36 (1.29) | 3.16 (1.07) | 2.94 (1.24) | 3.07 (1.13) |
| 14. Familiarity with VR | 2.92 (2.55) | 4.76 (2.68) | 3.79 (2.78) | – – | – – | – – |
| 15. Technology acceptance | 4.38 (1.42) | 4.16 (1.35) | 4.35 (1.43) | – – | – – | – – |

## Correlation analysis

As reported in Table 2, reading in virtual reality was associated with higher levels of intention to read, transportation, empathy and its subscales, affective and associative empathy. There were significant strong positive correlations between participants' intention to read the story further and their perceived levels of narrative absorption and empathy. Significant positive correlations were found for all the control variables – except age and level of education – with intention to read, narrative absorption, and empathy. Gender correlated with intention to read. Based on these results, age and education were not included in further analyses.

**Table 2.** Pearson correlations between media format, intention to read further, narrative absorption, empathy, and control variables. $n = 83$ (for gender, $n = 82$; for age, $n = 81$).

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Media format | | | | | | | | | | | | | | | | |
| 2. Intention to read | .25$^{\dagger}$ | | | | | | | | | | | | | | | |
| 3. Narrative absorption | .15 | .66$^{**}$ | | | | | | | | | | | | | | |
| 4. Attention | .11 | .64$^{**}$ | .87$^{**}$ | | | | | | | | | | | | | |
| 5. Transportation | .30$^{*}$ | .54$^{**}$ | .87$^{**}$ | .74$^{**}$ | | | | | | | | | | | | |
| 6. Emotional engagement | .11 | .57$^{**}$ | .85$^{**}$ | .60$^{**}$ | .68$^{**}$ | | | | | | | | | | | |
| 7. Mental imagery | –.04 | .46$^{**}$ | .75$^{**}$ | .55$^{**}$ | .45$^{**}$ | .58$^{**}$ | | | | | | | | | | |
| 8. Empathy | .26$^{\dagger}$ | .61$^{**}$ | .74$^{**}$ | .61$^{**}$ | .69$^{**}$ | .71$^{**}$ | .46$^{**}$ | | | | | | | | | |
| 9. Affective empathy | .23$^{\dagger}$ | .59$^{**}$ | .72$^{**}$ | .58$^{**}$ | .65$^{**}$ | .70$^{**}$ | .45$^{**}$ | .86$^{**}$ | | | | | | | | |
| 10. Cognitive empathy | .20 | .48$^{**}$ | .58$^{**}$ | .44$^{**}$ | .54$^{**}$ | .57$^{**}$ | .38$^{**}$ | .88$^{**}$ | .62$^{**}$ | | | | | | | |
| 11. Associative empathy | .25$^{\dagger}$ | .55$^{**}$ | .68$^{**}$ | .60$^{**}$ | .63$^{**}$ | .63$^{**}$ | .40$^{**}$ | .92$^{**}$ | .67$^{**}$ | .74$^{**}$ | | | | | | |
| 12. Transportability | .19 | .38$^{**}$ | .57$^{**}$ | .49$^{**}$ | .52$^{**}$ | .44$^{**}$ | .44$^{**}$ | .57$^{**}$ | .49$^{**}$ | .43$^{**}$ | .58$^{**}$ | | | | | |
| 13. Reading frequency | .17 | .34$^{*}$ | .33$^{*}$ | .29$^{*}$ | .28$^{\dagger}$ | .27$^{\dagger}$ | .28$^{*}$ | .39$^{**}$ | .41$^{**}$ | .25$^{\dagger}$ | .37$^{**}$ | .52$^{**}$ | | | | |
| 14. Familiarity with the story | .12 | .50$^{**}$ | .34$^{*}$ | .31$^{*}$ | .26$^{\dagger}$ | .26$^{\dagger}$ | .30$^{*}$ | .29$^{*}$ | .24$^{\dagger}$ | .19 | .32$^{*}$ | .24$^{\dagger}$ | .36$^{*}$ | | | |
| 15. Gender | –.02 | .22$^{\dagger}$ | .13 | .09 | .18 | .03 | .11 | .03 | .07 | .02 | –.01 | –.01 | .15 | .24$^{\dagger}$ | | |
| 16. Age | –.10 | –.12 | –.10 | –.08 | .01 | –.15 | –.13 | .08 | –.03 | .18 | .06 | –.10 | .05 | –.01 | -.05 | |
| 17. Education | –.11 | .04 | 0 | 0 | .02 | –.01 | –.02 | .03 | –.06 | .10 | .05 | –.23$^{\dagger}$ | –.15 | .08 | –.01 | .62$^{**}$ |

$^{\dagger}p < .05$; $^{*}p < .01$; $^{**}p < .001$.
Bias-corrected and accelerated 95% bootstrap, sample size = 5,000. Coding of media format: Print =1, VR = 2.

Within the subsample of the VR condition, technology acceptance correlated with narrative absorption ($r = .64$, $p < .001$) and all its subscales, empathy ($r = .42$, $p = .005$) and all its subscales, and intention to read ($r = .39$, $p = .01$). Familiarity with VR technology did not significantly correlate with any of the other variables (see Appendix, Table 4).

## Hypotheses testing

**Effect of VR on SWA (H1), Empathy (H2) and Intention (H3).** First, data was submitted to a MANOVA analysis with media format as independent variable, and aggregated scale of narrative absorption, empathy, as well as intention to read as dependent variables (*Model 1*). Using Pillai's trace, the result showed a significant effect of media format on the level of narrative absorption, empathy and intention to read, V = 0.10, $F(3,79) = 2.83$, $p = .04$, $\eta_p^2 = .10$. Separate univariate ANOVAs on the outcome variables indicated a non-significant effect of

media format on narrative absorption, $F(1,81) = 1.87$, $p = .17$, and a significant effect on empathy, $F(1, 81) = 5.84$, $p = .02$, $\eta_p^2 = .07$, and intention to read, $F(1,81) = 5.65$, $p = .02$, $\eta_p^2 = .06$. The results indicate that VR compared to printed book format increased the level of empathy and intention to read (see descriptive statistics in Table 1).

Secondly, we included the covariates of gender, transportability, reading frequency, and familiarity with the story into Model 1 (*Model 2*). The results showed that there was no significant effect of VR on narrative absorption, empathy, and intention to read, V = 0.06, $F(3, 75) = 1.69$, $p = .18$). However, there were significant medium sized effects of transportability (V = 0.29, $F(3, 75) = 10.08$, $p < .001$, $\eta_p^2 = .29$) and familiarity with the story (V = 0.15, $F(3, 75) = 4.54$, $p = .006$, $\eta_p^2 = .15$).

Taking Model 1 and Model 2 together, it can be seen that VR increases the level of empathy and intention to read, confirming Hypotheses 2 and 3, however, this effect disappears when the covariates are considered. Media format did not affect narrative absorption, therefore Hypothesis 1 has to be rejected.

**Effect of VR on SWA subscales, Empathy subscales, and Intention to read.** First, to zoom into the effect of media format on the narrative absorption subscales, the empathy subscales, and intention to read, data was submitted to a MANOVA analysis with media format as independent variable, and narrative absorption subscales, empathy subscales and intention to read as dependent variables (*Model 3*). Employing Pillai's trace, the result indicated a significant effect of media format on the level of narrative absorption subscales, empathy subscales and intention to read, V = 0.22, $F(8,74) = 2.57$, $p = .02$, $\eta_p^2 = .22$. Separate univariate ANOVAs on the outcome variables showed a significant effect of media format on affective empathy, $F(1,81) = 4.54$, $p = .04$, $\eta_p^2 = .05$, and associative empathy, $F(1,81) = 5.59$, $p = .02$, $\eta_p^2 = .06$, as well as SWA transportation, $F(1,81) = 7.80$, $p = .01$, $\eta_p^2 = .09$, and intention to read, $F(1,81) = 5.65$, $p = .02$, $\eta_p^2 = .06$. The results indicated that VR compared to printed book format increased affective empathy, associative empathy, transportation and intention to read (descriptive statistics presented in Table 1).

Secondly, we included the covariates of gender, transportability, reading frequency, and familiarity with the story into Model 3 (*Model 4*). After the first round of analysis, we removed reading frequency as it showed an overall non-significant effect, V = .05, $F(8,70) = 0.61$, $p = .85$, leaving gender, transportability, and familiarity with the story as covariates in Model 4. Using Pillai's trace, the results showed that there were significant medium sized effects of media format, V = 0.20, $F(8, 71) = 2.25$, $p = .03$, $\eta_p^2 = .20$, and of transportability, V = 0.37, $F(8, 71) = 5.25$, $p < .001$, $\eta_p^2 = .37$), as well as familiarity with the story, V = .20, F(8, 71) = 2.29, p = .03, $\eta_p^2 = .20$, on the outcome variables. Follow-up separate ANCOVAs showed that media format had a significant small effect on transportation into the story world ($F(1, 78) = 5.25$, $p = .03$, $\eta_p^2 = .06$). Contrasts revealed that reading in VR compared to the book format increased transportation into the story world ($b = .51$, $SE = .23$, $t(78) = 2.19$, $p = .03$). Transportability was positively related to all dependent variables ($F(1, 78) = 6.84 – 30.73$, $p = .000$ - $.011$, $\eta_p^2 = .08$ - $.28$). Familiarity with the story was related to intention to read the story further, $F(1, 78) = 15.33$, $p > .001$, $\eta_p^2 = .16$. Moreover, gender was significantly related to transportation into the story world ($F(1, 78) = 4.50$, $p = .04$, $\eta_p^2 = .05$). Contrasts revealed that women felt more transported into the story world ($b = .50$, $SE = .23$, $t(78) = 2.12$, $p = .04$) and a higher level of familiarity with the story increased intention to read ($b = .49$, $SE = .12$, $t(78) = 3.92$, $p < .001$).

Taking Model 3 and Model 4 together, we observed that VR did not increase attention and emotional engagement, therefore H1.1 and H1.2 had to be rejected, however, it increased associative empathy, affective empathy and intention to read, which confirms H2.1, H2.2 and H3. Regarding RQ1.1 and RQ1.2, transportation was increased by VR, however mental imagery was not.

**Mediation analysis (RQ3).** *Three mediators (Mediation Model 1).* Building on the MANOVA analysis (Model 3), we included media format as predictor variable, intention to read as outcome variable, and the transportation subscale, affective, and associative empathy subscale as mediator variables. The indirect effect hypothesis was tested using a bootstrap estimation approach with 5,000 samples in PROCESS Model 6 (Hayes, 2018). We employed the Model 6 statistical analysis that tested seven mediation models. The results showed that the relationship between media format and intention to read was serially mediated by transportation and affective empathy. The mediating effect of associative empathy was shown to be non-significant. As Table 3 shows VR increased transportation, which in turn increased affective empathy and through that, intention to read. *Two mediators with covariates (Mediation Model 2).* In an additional analysis, we removed associative empathy from the mediators. We repeated the test with media format as predictor variable, intention to read as outcome variable, the transportation subscale, and affective empathy subscale as mediator variables, as well as gender, transportability, and story familiarity as covariates. We employed the Model 6 statistical analysis that tested three mediation models. The results showed that even when including the covariates, the indirect effect of media format on intention to read through transportation and affective empathy is significant, $b$ = .08, SE = .05, BCa 95% CI [.004, .189] (Figure 4). This model was significant ($p$ < .001) and can explain 36% of the variance. We repeated the analysis to check the serial effect of affective empathy toward transportation, which was not significant, $b$ = –.02, BCa CI [–.08; .01].

**Table 3**. Mediation Model 1 ($R^2$ = .09). Partially standardized indirect effect(s):

| Indirect effect type | | *b* | SE | [LL, UL BCa 95% CI[b]] |
|---|---|---|---|---|
| Ind1 | Media format → Transportation → Intention to Read | .10 | .09 | –.034, .305 |
| Ind2 | Media format →Affective Empathy → Intention to Read | .03 | .06 | –.090, .166 |
| Ind3 | Media format → Associative Empathy → Intention to Read | .02 | .04 | –.053, .125 |
| Ind4 | Media format → Transportation → Affective Empathy → Intention to Read | .12* | .07 | .010, .288 |
| Ind5 | Media format → Transportation → Associative Empathy → Intention to read | .04 | .03 | –.008, .112 |
| Ind6 | Media format → Affective Empathy → Associative Empathy → Intention to Read | .01 | .02 | –.037, .050 |
| Ind7 | Media format → Transportation → Affective Empathy → Associative Empathy → Intention to read | .03 | .03 | –.006, .106 |

[b]Bootstrap sample size = 5,000; Ba 95% CI, bias-corrected and accelerated confidence interval; LL, lower limit; UL, upper limit.

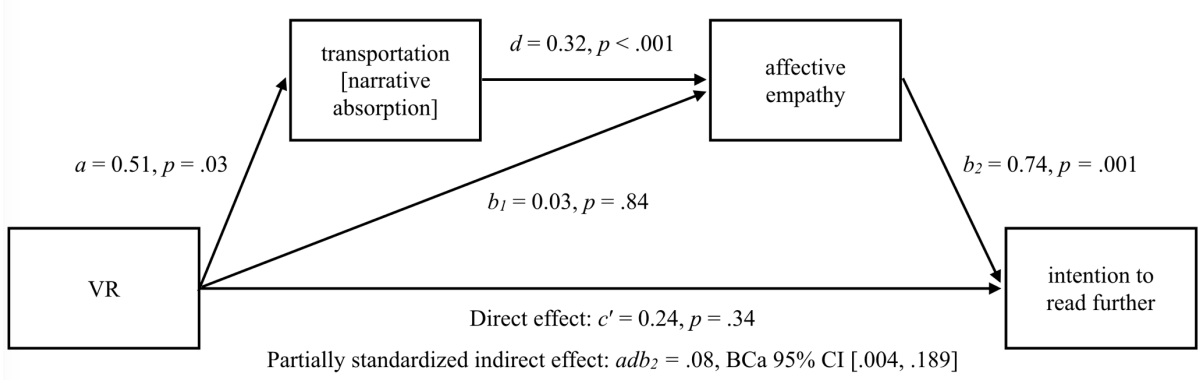


**Figure 4.** Effect of VR on intention to read as a serial mediation of transportation into the story world and affective empathy, with gender, transportability, and familiarity with the story as covariates (Model 2).

## Discussion

In this study, we investigated whether reading a fictional narrative presented in virtual reality as opposed to print format can increase readers' narrative absorption, state empathy and intention to read. Furthermore, we tested if narrative absorption and affective empathy are relevant mediators of this effect. Participants who read the text in VR reported higher level of state empathy, intention to read, as well as transportation. Moreover, transportation and affective empathy were found to fully mediate the effect of VR on intention to read. On the other hand, media format did not influence narrative absorption, and the subscales of attention, emotional engagement, and mental imagery. Important to mention, the effect of media format on state empathy and intention to read was not significant when we included the control variables.

The results indicate that VR had no effect on narrative absorption in general, however, it increased the subscale of transportation, that is the sense of deictic shift into the story world. It seems that the effect of VR is exerted through transportation, rather than through attention, emotional engagement, or mental imagery. It can be that the text was too short to induce these responses and to fully engage readers into the story world. This study is the first to test the effect of VR on reading, hence our understanding of the aesthetic dynamics involved in the use of VR for entertainment is still unclear. Further research should employ fictional narratives specifically manipulated to test these associations.

We also found that VR increased participants' state empathy, affective empathy and associative empathy in particular, however it had no effect on cognitive empathy. This indicates that VR helps readers share the characters' emotions and identify with their perspectives directly, and not through an effortful cognitive process, such as perspective taking. Further research needs to replicate these findings on larger sample size to see if the lack of significant effects is due to small power.

Reading in VR increased participants' intention to read, and this effect was fully mediated by the serial mediation of transportation and affective empathy. This result indicates that VR elicits transportation, and this sense of being present in the fictional story world contributes to reader's sharing of the characters' emotional state, which in turn increases intention to read the story further. This is in line with previous findings on the potential of VR to increase the sense of spatial presence in a *visually* presented environment (Cummings and Bailenson, 2016), and our study is the first to show that VR can also increase the sense of transportation in a *textually* presented fictional story world. Moreover, the data confirmed that VR is associated with affective empathy but not on cognitive empathy (Martignano et al., 2019), also bringing evidence that clarify how this association is due to transportation into the story world.

The analyses showed an important role of the covariates: transportability and gender are related to transportation into the story world, and familiarity with the story influences intention to read. Female participants' stronger intention to read is related to their stronger feeling of transportation into the story world. For VR, the secondary analysis revealed the important role of technology acceptance: higher levels of technology acceptance were associated with higher levels of narrative absorption, state empathy and intention to read further. This indicates that the extent to which people see VR as a useful and easy-to-use tool for reading can strengthen its effect on the outcome variables. This is contrasting with research on the differences between reading on paper and on screen, which claim that the more technology becomes integrated into our lives the more our reading performance on screen worsen (Clinton, 2019; Delgado et al., 2018). Two factors can explain this divergence: first, the focus of our study was not reading comprehension but aesthetic reader response, which is not commonly considered in meta-analyses on reading; second, we specifically used an immersive digital media format, to which the critique of being "distracting" does not apply in the same way as for mobile phones and

tablets (Annisette & Lafreniere, 2017; Mangen et al., 2019; Mangen & Kuiken, 2014). Indeed, even though we found no significant effect on attention, reading in VR eliminates distractions due to possible notifications on the device and external factors as well. It is also worth noting that the level of prior experience with VR did not influence readers' narrative experiences, thus the novelty effect of using this technology did not affect readers' response.

## Outlook and future research

These promising results have been obtained using the first chapter of the novel *Alice's Adventure in Wonderland*, but in order to confirm that VR can be effectively used to promote reading in different contexts (educational and recreational) further studies need to be done with different stories and genres, and exploring how the various features of VR affect the aesthetic experience. The results are particularly significant if we consider that half of the participants rarely reads fiction or does not read it at all.

With respect to methodology, a critical issue is how to distinguish "narrative absorption", which concerns the way a story is told and the story world it creates, from "presence", which concerns the world displayed in VR and the interaction with it. In other words, how to distinguish immersion in the story world (Ryan, 2015) and immersion in the VR world (Witmer & Singer, 1998). Both narrative absorption and presence are multidimensional constructs – depending on the definitions, presence can subsume "spatial presence", "social presence", "realism/ecological validity", "engagement", or other variations of these concepts (Skarbez et al., 2017) – and the questionnaires used to grasp these two states show that there is a possible limitation in the use of existing self-reported measure tools, since the items are very similar. For instance, the narrative absorption (transportation into the story world subscale) item "When I was finished with reading the story it felt like I had taken a trip to the world of the story" (Kuijpers et al., 2014) is very similar to the spatial presence item "After my experience of the displayed environment, I had a sense that I had returned from a journey" (Lessiter et al., 2001). This is also the case with other items of questionnaires used to measure presence. This inadequacy of instruments is due to the fact that research on VR narratives is usually focused on visual narratives (films, documentaries, and games), thus there is no need to distinguish between the effect of the story and that of the displayed visuals.

When VR space and non-visual narrative have been combined, contradictory results have been found: in some cases, there was a significant effect of narrative on presence (subdimensions "spatial presence" and "engagement with the VR space") (Baños et al., 2004; Gorini et al., 2011); in another case, narrative priming did not affect viewers' response (Rooney et al., 2017). Results concerning the effect of narrative on VR engagement – compared to non-narrative – are similar to what has been found in research with written fiction, as already mentioned. With respect to spatial presence, the interest of this concept for research on narrative and fiction lies in the possible effect of VR on narrative absorption, not in the inverse relation, as it is usually the case for VR research. Interestingly, in developing a spatial presence scale (SPES), Hartmann et al. (2016) also used books and hypertexts as stimulus material. However, the authors expect the scale's two dimensions – "self-location" and "possible actions" – "to be unrelated to, for example, users' parasocial interaction with media characters" (p. 11), although they did not test this possibility. There are many overlapping concepts that have been formulated in the different fields, according to specific disciplinary interests, based on the knowledge within the field. However, in an era of media convergence (Jenkins, 2006) and multimodal narratives (Kress, 2003) an interdisciplinary effort is very much needed in order to better understand the effect of new forms of entertainment and art.

Beside the theoretical overlap, since reading in VR is a multimodal experience involving text, audio, and visuals as part of the overall aesthetic experience, another issue concerns the readers' ability to distinguish between narrative absorption and presence. A similar issue is still open for empirical studies with textual narrative as well: acknowledging a limitation of the SWAS, Kuijpers et al. (2017) suggest to distinguish between "story world absorption" and "artifact absorption", that is between absorption linked to character and events, and absorption linked to style ("the artifice of the story", p. 39). The two states are intertwined and are both part of overall aesthetic absorption. Further research and theoretical reflection are needed to understand how to grasp the different aspects of absorption and presence in multimodal narrative aesthetic experiences.

Regarding empathy, our research contributed to confirm that people relate to others at least in two ways, affectively and cognitively (Yu & Chou, 2018), and fiction and VR affect these modalities in different ways. Current empathy theories and scales allow for a good distinction but, when considering fiction, more nuanced tools are needed to account for the various forms of perspective-taking prompted by different narrative modes, e.g. first-person or third-person narration (Lissa et al., 2016), goal directed actions (Speer et al., 2009), trust in the narrator (Archer & Finger, 2018). Moreover, beside emotional response and conscious mentalizing, another kind of empathic response particularly relevant for fictional narrative should be considered: embodied response (Burke et al., 2016). More broadly, the embodied and enactive activation due to reading fiction (Caracciolo, 2014; Sukalla et al., 2016) should be taken into account with respect to its convergence and dissonance with the embodied and enactive sense of presence in a visually presented virtual environment (Skarbez et al., 2017). The challenge to find the best characteristic for this kind of virtual environments is open, our study contributed by finding that VR indeed has a potential to promote reading through its capability to intensify transportation and affective empathy.

## Limitations

Despite having found that the sense of transportation in a textually presented fictional story world can be increased by VR, our study did not investigate what features of VR are responsible for this effect. We used a virtual environment loosely congruent with the story, but we do not know whether the association between the displayed environment (a garden) and the initial story setting (a meadow) was significantly related to the outcome. The relationship between visual stimuli, mental imagery, and transportation will also need to be further explored, both using virtual environments that match the story setting and virtual environments unrelated to it. Moreover, as already mentioned in the theoretical section, it is possible that some of the answers to the transportation questionnaire items are an artifact of perceiving to be in the world displayed through VR rather than the story world. Indeed, our results seems to contradict the expectation that spatial presence (a construct measured with items similar to those of the SWAS transportation subscale) is unrelated to engagement with the characters (Hartmann et al., 2016). A different experimental design is needed to test the difference between transportation and presence when reading in VR.

A limitation of the experimental setting is that there was no audio component in the VR condition, thus participants could hear sounds from the physical world in which their body was located. Although they were in a room alone and the Department's corridor was silent, the use of headphones and ambient sounds would have helped to better account for the potential of VR. Regarding the stimulus material, the choice of a story as popular as *Alice's Adventures in Wonderland* may have influenced readers' response independently from media format, a

possibility suggested also by the strong association of the covariate "familiarity with the story" with the dependent variable "intention to read".

**Conclusion**

To conclude, presenting fictional stories in a VR format seems to be a promising way to enhance people's experience with reading, and in turn, increase their intention to read. Based on the present experimental research, transportation, that is the deictic shift into the story worlds, and affective empathy, that is the sense of sharing the emotions of the character, were found to be important mediators of the positive effect of VR on intention to read. We found that the effect of VR is serially mediated through transportation and affective empathy. This study is the first to show the potential of VR to promote reading.

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# Appendix

## Table 4

Pearson correlations between intention to read further, narrative absorption (with subscales), empathy (with subscales), and control variables in the VR subgroup. $n$ = 42 (for gender, $n$ = 41; for age, $n$ = 40)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Intention to read | | | | | | | | | | | | | | | | | |
| 2. SWAS | .67** | | | | | | | | | | | | | | | | |
| 3. Attention | .67** | .92** | | | | | | | | | | | | | | | |
| 4. Transportation | .55** | .91** | .86** | | | | | | | | | | | | | | |
| 5. Emotional engagement | .62** | .89** | .73** | .76** | | | | | | | | | | | | | |
| 6. Mental imagery | .51** | .78** | .60** | .55** | .65** | | | | | | | | | | | | |
| 7. Empathy | .66** | .81** | .71** | .77** | .74** | .62** | | | | | | | | | | | |
| 8. Affective empathy | .63** | .78** | .68** | .74** | .74** | .56** | .92** | | | | | | | | | | |
| 9. Cognitive empathy | .55** | .71** | .60** | .66** | .62** | .60** | .88** | .71** | | | | | | | | | |
| 10. Associative empathy | .62** | .73** | .66** | .71** | .65** | .53** | .93** | .80** | .74** | | | | | | | | |
| 11. Transportability | .33† | .61** | .53** | .56** | .46* | .58** | .60** | .58** | .47* | .59** | | | | | | | |
| 12. Reading frequency | .45* | .44* | .39† | .41* | .36† | .39† | .51** | .54** | .34† | .50** | .69** | | | | | | |
| 13. Familiarity with the story | .59** | .25 | .30 | .21 | .21 | .15 | .26 | .25 | .16 | .29 | .22 | .45* | | | | | |
| 14. Gender | .35† | .18 | .15 | .09 | .16 | .24 | .15 | .18 | .10 | .11 | –.04 | .14 | .37† | | | | |
| 15. Age | –.35† | –.30 | –.25 | –.14 | –.29 | –.35† | –.06 | –.12 | .01 | –.04 | –.17 | –.23 | –.12 | –.22 | | | |
| 16. Education | –.06 | –.13 | –.08 | –.08 | –.09 | –.21 | –.01 | –.07 | .04 | .01 | –.32† | –.33† | –.09 | 0 | .53** | | |
| 17. Familiarity with VR | –.05 | –.02 | .06 | –.02 | –.03 | –.10 | .05 | .05 | .06 | .04 | .29 | .22 | .11 | –.34† | .15 | –.12 | |
| 18. Technology acceptance | .39† | .64** | .58** | .59** | .53** | .55** | .42* | .34† | .50* | .34† | .35† | .25 | .10 | .08 | –.09 | –.02 | –.01 |

†$p$ < .05; *$p$ < .01; **$p$ < .001. Bias-corrected and accelerated 95% bootstrap sample size = 5,000.