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From virtual to prosocial reality: The effects of prosocial virtual reality games on preschool Children's prosocial tendencies in real life environments

Anat Shoshani *

Baruch Ivcher School of Psychology, Reichman University (IDC Herzliya), Herzliya, Israel

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ABSTRACT

Virtual Reality (VR) technology can provide new opportunities to promote prosocial learning in young children. However, little empirical research has examined how this technology can impact preschool children's prosocial behavior. To respond to this need, two experiments investigated how VR prosocial games affect preschool children's prosocial behavior in real-life settings. Positive affect and sense of competence were examined as potential mediators between the VR prosocial play and real-life prosocial behavior. In the first experiment, 4-to 6-year-olds ($N = 166$) were randomly assigned to play a prosocial, violent, or neutral VR game. After the game, helping behaviors towards the experimenter were tested on a behavioral task. In the second experiment, 4-to 6-year-olds ($N = 173$) were randomly assigned to a prosocial, positive affect, or neutral VR game condition, and their sharing behavior with peers was examined on a dictator game. Across experiments, children in the prosocial game condition exhibited more helping and sharing behaviors than children in the violent, positive affect, or neutral conditions. Positive affect mediated the effect of VR prosocial play on prosocial behavior; the effect of competence was not significant. The contribution of gamified VR environments to facilitating prosocial development during the preschool age is discussed.

1. Introduction

In the past two decades, the use of virtual reality (VR) technology for leisure, education, and training has surged (Kavanagh et al., 2017). While computers and touch screens are the most popular media platforms among young children, there is increasing access to VR devices (Rideout, 2017). However, little research has examined the impact of VR on preschool children. Given the anticipated growth of VR use by young children (Bailey & Bailenson, 2017), it is crucial to investigate its influence on their development and behavior.

There are several potential advantages of VR use in young children. On one hand, VR environments enable young children to visit fictional locations and encourage them to broaden their imagination and minds (Schmitz et al., 2020). VR can also depict realistic situations and transform the ways in which young children learn from the media, because it is both engaging and motivating while facilitating situated learning and the transfer of knowledge to real world settings (Dede, 2009).

Recent studies confirm the efficacy of VR in supporting young children's learning and development. For example, VR is increasingly used in clinical settings with preschool children. Medical providers take advantage of VR to decrease children's physical and emotional pain during painful and stressful medical procedures (Nilsson et al., 2009; Wong et al., 2020; Özalp Gerçeker et al., 2020), and as a diagnostic tool for the assessment of Autism Spectrum Disorder (Alcañiz et al., 2022). VR applications have also been implemented to promote social skills in young children on the autism spectrum, such as nonverbal gesturing communication (Alcorn et al., 2011; Cai et al., 2013), and to improve motor skills and balance in preschool children with cerebral palsy (Arnoni et al., 2021; Farr et al., 2021). The use of VR has been shown to contribute to ameliorations in executive functions, attention, and working memory in young children with neurodevelopmental disorders (De Luca et al., 2021; Escobedo et al., 2014; Kerns et al., 2017).

VR is not solely restricted to rehabilitation or the treatment of disorders. A growing number of educational VR applications with different target groups and learning goals are on the market (Akçayır & Akçayır, 2017). For example, there are VR applications that introduce scientific concepts to preschool children (Roussos et al., 1998), teach geometric

* Baruch Ivcher School of Psychology, Reichman University (IDC Herzliya), P.O.Box 167, Herzliya, 46150, Israel.
E-mail address: ashoshani@runi.ac.il.

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shapes (Gecu-Parmaksiz & Delialioglu, 2019), or increase young children's vocabulary (Lee et al., 2017).

However, there is still scant research on the use of this technology to improve social abilities in general, and specifically for young children (Kavanagh et al., 2017). Even fewer studies have explored the ways in which VR can support children's prosocial behavior although prosocial VR games may contribute to developing preschool children's abilities to emotionally respond to others' needs and engage in altruistic and prosocial behavior.

VR is characterized by sensations of presence and immersion which enable children to feel they are part of the environment in which they are functioning (Bailey & Bailenson, 2017). It also can create a range of social and emotional situations by enabling children to interact with game characters using naturalistic self-movement and behaviors, similar to their experiences in the physical and social world (Bailey & Bailenson, 2017). These characteristics could thus serve as empowering platforms for practicing and enhancing prosocial abilities during early childhood.

Innate prosocial tendencies appear early on (Sloane et al., 2012; Vaish et al., 2010) with significant increases over the first 3 years of life (Hay, 1994; Knafo et al., 2008). There is a wealth of empirical data showing that one-to three-year-olds can cooperate, share, help, and comfort others in need, even in the absence of reciprocation or any personal reward (Aknin et al., 2012; Davidov et al., 2013; Eisenberg et al., 2006; Hamlin & Wynn, 2011; Hay & Cook, 2007; Svetlova et al., 2010; Warneken & Tomasello, 2009).

On the other hand, young children are not always prosocial to others (Zahn-Waxler at al., 1992), and their ability to act in less egocentric and self-focused ways increases with cognitive development during the ages of three to five as the abilities for more sophisticated forms of understanding of others' mental states and perspective taking develop. The growth of children's capacity to grasp the mental states of other people (i.e., desires, beliefs, and intentions) between the ages of 3–5, which is known as the Theory-of-Mind (Wellman et al., 2001), makes them more responsive and prosocial towards others (Eisenberg et al., 2006). By the age of five, almost all children tend to have a basic, useful ability for theory-of-mind (Wellman et al., 2001).

Socialization plays a central role in preschoolers' emerging prosociality by modeling responsive and empathic behavior, emphasizing other people's needs, and providing social rewards such as praise or positive reactions to the child's pro-social acts (Drummond et al., 2014; Eisenberg-Berg et al., 1981). Virtual reality can be used to achieve some of these objectives by incorporating a realistic simulation of a social environment that encourages prosocial behavior.

To begin to address this issue, the two experiments presented here investigated the effects of playing prosocial, violent, or neutral VR games on 4- to 6-year-olds' prosocial behavior in response to laboratory social situations immediately after game play. Positive emotions and prosocial competence during the VR game were examined as potential mediators of the effects of the VR prosocial game on children's prosocial behavior. Overall, the goal was to achieve a better understanding of the ways in which VR technology can promote prosocial skills in preschool children in real-world settings.

1.1. Digital games and prosocial learning

Explicit attention to the social effects of digital games on children's prosocial behavior emerged in the 2000s, particularly in the work of Buckley and Anderson (2006). Buckley and Anderson drew on studies by Anderson and Bushman (2001) dealing with violent media effects to define a General Learning Model (GLM) which addressed the influence of media on human social behavior (Buckley & Anderson, 2006).

For these researchers, digital games are platforms for social learning. Prosocial digital games evoke prosocial behavior through arousal, positive emotions, and prosocial cognitions that are related to the game contents. These variables affect the processing of social situations and determine prosocial behavioral reactions (Buckley & Anderson, 2006). Violent video games, in contrast to prosocial ones, increase arousal, prime aggressive cognitions, and create an aggressive emotional state that may lead to aggressive real-life behaviors such as delinquency, bullying, and frequent involvement in fights (Anderson & Bushman, 2001; Anderson et al., 2007; Buckley & Anderson, 2006; Hopf et al., 2008).

Multiple learning mechanisms of observational learning, behavioral conditioning, and recurrent practice work both serially and in parallel to yield learning social outcomes that are related to the game experience (Gentile et al., 2014; Greitemeyer, 2022). When digital games include prosocial content such as game characters that act in kind, caring, and helpful ways, prosocial emotions and behavioral scripts are frequently primed and rehearsed (Greitemeyer, 2011). These feelings and scripts also prompt players to behave prosocially in real life situations immediately after playing (Buckley & Anderson, 2006). Repeated prosocial game experiences can lead to prolonged changes in cognitions, behaviors, and affect through their impact on the players' cognitive constructs such as attitudes and stereotypes, and personality traits such as empathy or kindness (Gentile et al., 2009).

Relatively few studies have examined the possible associations between digital games and the level of prosocial functioning in early childhood. Empirical studies on older children and adolescents show that violent video games are linked to an increase in physical aggression (e.g., Anderson et al., 2007; Gabbiadini et al., 2012; Gentile et al., 2011; Wallenius & Punamäki, 2008), and a decline in sharing and helping behaviors (Gentile et al., 2014). In contrast, cooperative and prosocial video gameplay have been related to increased prosocial behavior (Gentile et al., 2009; Greitemeyer, 2022; Greitemeyer & Cox, 2013; Greitemeyer & Osswald, 2010; Saleem et al., 2012; Shoshani & Krauskopf, 2021). Studies have found that playing a prosocial video game increases cooperation, sharing, helping, and other types of prosocial behavior in children and adolescents (Gentile et al., 2009; Greitemeyer & Mügge, 2014; Harrington & O'Connell, 2016; Shoshani et al., 2021; Shoshani & Krauskopf, 2021).

Despite the growing literature on prosocial digital game play, there are few studies on the ways in which video game social experiences affect the prosocial behavior of young children. In the handful of studies that have focused on the prosocial effects of digital video games on preschool children, there has been some attempt to distinguish between the effects of the prosocial content (i.e., benefiting game characters as the goal of the game) and context of the games (i.e., benefiting other players during game play). For example, Arnott (2016) found that 3- to 5-year-olds exhibited a range of prosocial behaviors during digital media use in preschool settings when interacting with their peers, such as helping each other, sharing resources, exchanging ideas, and cooperating with each other. In contrast, in a study with dyads of 4 to 10-year--olds that compared digital and analog game play, children in the digital game condition communicated less with each other, responded less often to the interaction attempts of their playmates, and showed more negative forms and fewer positive forms of interaction than children in the analog condition. However, the type of medium had no significant effect on prosocial behavior after the game (von Steinkeller & Grosse, 2022).

A separate line of research examining the content of children's media exposure reported that violent media exposure on television shows, movies and video games was associated with future observed aggression among 4-year-olds, whereas educational media was associated with concurrent prosocial behavior (Ostrov et al., 2006). By contrast, studies on the effects of prosocial touch-screen applications on children's socio-emotional skills have found increases in empathy, emotion recognition and regulation, and helping behavior in laboratory tasks after playing prosocial games, and lower prosociality after playing violent games (Rasmussen et al., 2016, 2019; Shoshani et al., 2022). However, there is relatively little work on the social effects of VR games on young children within the vast body of research devoted to this topic in general.

1.2. Virtual reality to enhance prosocial skills

VR has a variety of forms, ranging from PC computers or VR headsets that require a cell phone and which present highly interactive virtual environments, to a fully multisensory and immersive environment in academic laboratories (Mikropoulos & Natsis, 2011). In recent years, VR devices have become more user-friendly and their cost has begun to decrease, so that more research is being conducted in schools and educational settings (Lorusso et al., 2020).

VR has intrinsic appeal as a social learning tool for preschool children who tend to learn better from concrete illustrations and real experiences using visual presentations (Reisoğlu et al., 2017). A VR-based social learning environment allows children to practice and develop social skills in a synthetic but realistic, nonthreatening, controllable, diversifiable, and motivating environment during learning (Blascovich et al., 2002). There is growing evidence that VR technology represents authentic social encounters and scenarios in which children respond and behave in a similar manner in the virtual world as they do in the real world (Georgescu et al., 2014; Schmidt & Schmidt, 2008). Furthermore, studies with children and adults have shown that the brain responds to VR situations as though they were real (Bohil, Alicea, & Biocca, 2011).

The first-person viewpoint in VR platforms create the illusion of realness of the virtual environment and a sense of sharing the same space with other game characters (Bailey & Bailenson, 2017). The social engagement features and virtual game characters' contingency clues, such as body movements, eye contact, shared context, proximity, verbal responses, and vocal changes, may increase the prosocial effects of the game experience on real-life prosociality (Ke, Moon, & Sokolikj, 2022). Prosocial scripts and behaviors can be learned by imitating virtual characters' socially constructive acts, or by practicing prosocial behaviors in the virtual social environment (Bailey et al., 2019).

While children are playing a VR social game, they repeatedly practice a particular social skill or skills over time. The extent to which the skills used in the game can be applied to social situations outside the game context can be viewed as the extent of transfer of that social skill (Mayer & Wittrock, 1996). Since VR social contexts are interactive, multisensory, and ecologically representative, they can trigger the same social processes and the same behaviors children engage in during their everyday lives. Thus, the VR interface is likely to facilitate greater transfer of these learned behaviors and skills to real world environments than computer-based or touch-screen systems (Saiano et al., 2015).

Near transfer, which refers to the generalization of behaviors in the VR environment to a similar situation in the real world, is very likely to occur, especially when the prosocial activities in the game closely mimic social behavior in real-life settings (Mayer, 2014). Findings indicate that preschool children are able to transfer social abilities, motor skills, arithmetic knowledge, and linguistic skills from VR to real life (Gecu-Parmaksiz & Delialioğlu, 2020; Lorusso et al., 2020; Mowafi & Abumuhfouz, 2021; Pan et al., 2021; Redondo et al., 2020; Ren & Wu, 2019; Stotz & Columba, 2018; Zhou et al., 2020).

Blascovich et al. (2002) suggested that when virtual characters within VR environments act socially real, players tend to believe that they are real persons, and are more influenced by them. For example, Claxton and Ponto (2013), administered a decision making task to 5-, 7-, and 9-year-olds. The children were given information from a virtual reality character or a live person. The 7- and 9-year-olds preferred the information provided by the live person, whereas the 5-year-olds used the information from the virtual character and the live person equally. In addition, many preschoolers develop emotionally-tinged relationships with their favorite video game and media characters (Calvert et al., 2014; Howard Gola et al., 2013). Characters in VR can be perceived as more real than in less immersive media. By developing an attachment to game characters, VR can facilitate social learning opportunities that are different from non-immersive virtual mediums (Blascovich et al., 2002).

Despite these potential benefits, there are few studies on the effects of prosocial VR games on preschool children. In a recent study, 4- to 6-year-olds played Simon Says with a virtual character of Grover from Sesame Street©, either via a VR head-mounted display or a 2D television screen. The children showed more prosocial behaviors (shared more stickers with Grover) in the VR condition (Bailey et al., 2019). Lorusso et al. (2020) designed a set of VR games designed to stimulate perceptual and cognitive functions as well as social skills. The results showed that the VR activities stimulated social interactions and cooperation in a group of 25 kindergarten children. Despite the prosocial constructs investigated in these studies, the VR environments did not focus solely on prosocial behaviors, and no deliberate prosocial inducing elements or tasks were included in these environments.

Previous studies in this area have primarily been conducted on adults. Specifically, in a study of undergraduate students, Gillath et al. (2008) found that participants who were exposed in a VR environment to a virtual person in need (a blind man who was involved in accident), expressed concern and offered help, similar to scenarios in the real world involving people in need. In another study, adult participants who were given the ability to fly like Superman in a VR environment and were asked to find a lost child showed greater subsequent helping in the real world than participants who were passengers in a virtual helicopter (Rosenberg et al., 2013). These results may imply that VR can influence prosocial behavior for some time after the VR experience.

1.3. Potential mediators of VR prosocial effects

Few studies have explored why or how prosocial VR play promotes prosocial behavior among young children. It remains unclear which psychological processes that enable prosocial behavior in the virtual environment lead to higher levels of sharing or helping outside it.

The current study approached this question by drawing on the theoretical distinction between agency and positive affect. Psychologists have long recognized that people have basic motivations that are associated with prosocial behavior. These include feeling personally agentic or competent (Bandura, 1977), and feeling positive emotions about the self (Fredrickson & Joiner, 2002). In addition to the evaluation of the impact of VR prosocial games on young children, we compared the agentic and positive affect mechanisms that were likely to mediate the effects of VR prosocial experiences on prosocial behavior in real-world settings.

From an agentic standpoint, expressions of prosocial behavior in the virtual environment may enhance children's sense of self-efficacy, which could encourage them to engage in further prosocial behavior by lessening feelings of uncertainty and doubt as to whether they are able to help others effectively. Self-efficacy refers to the feeling of being competent and able to act effectively to achieve a desirable outcome (Bandura, 1977). Extensive literature has shown that when children feel competent and efficacious in a particular activity, they are motivated to invest time in it because they believe that their efforts will be successful (Ryan & Deci, 2000).

Young children withhold help when they are uncertain about their ability to help effectively and competently, and therefore do not always respond to individuals in distress with prosocial behavior (Zahn-Waxler at al., 1992). Peterson (1983) showed that preschoolers whose level of prosocial competence was enhanced by training in specific helping skills were more willing to assist after this training. Engaging repeatedly in prosocial behavior in virtual reality environments may thus reduce uncertainty as to the ability to help successfully.

In addition, positive reactions and gratitude from a beneficiary in the VR environment can reassure children that they have succeeded in benefiting the recipients, thus satisfying young children's basic drives to feel effective and capable (Shoshani et al., 2020). When they feel efficacious, children become more willing to help in real life settings because they believe that their efforts will enhance their odds of successfully helping others (Ryan & Deci, 2000). Here, this led to the hypothesis that prosocial acts in the VR environment should lead to a greater sense of competence, which should motivate children to engage

in further prosocial behavior.

From the standpoint of positive affect, focusing prosocially on others in the VR world may enhance positive emotions such as feelings of pride, satisfaction, and social worth, which may motivate children to act in a more prosocial way toward others (Erreygers et al., 2019). The broaden-and-build theory of positive emotions (Fredrickson, 2001) posits that positive emotions lead to a wider range of thoughts, attention, and actions. Mounting evidence suggests that being kind to other people (i.e., engaging in prosocial activities) consistently leads to increases in positive emotions and happiness (Aknin et al., 2012; Chancellor et al., 2018; Otake et al., 2006; Weinstein & Ryan, 2010). When children engage in acts of care and kindness for others, they may experience more opportunities to feel positive emotions such as trust, pride, and love within that relationship (Shoshani et al., 2020). Thus, it is also possible that when children behave in prosocial ways in the VR environment, they will feel more positive emotions, which will motivate them to engage in more prosocial behavior outside the game, in a real-world context.

1.4. The present study

The present study examined whether playing a VR game that involves prosocial contents and activities (i.e., helping and cooperating with a virtual character) would lead preschool children to be more prosocial in the real world. Specifically, we explored whether prosocial practice in the VR environment would lead to subsequent helping and sharing behaviors.

In two experiments, preschoolers were randomly allocated to a prosocial, violent/positive affect (in Experiment 1 and Experiment 2 respectively), or neutral VR game condition, using a mobile-based VR headset. In the prosocial condition, the players played a VR game (Peronio, Ovni Studios) in which they had to help a little boy who cannot decide what he wants to be when he grows up, to deal with different activities associated with different professions. After the VR experience, helping behaviors toward the experimenter (Exp. 1) and sharing behaviors towards peers (Exp. 2) were tested on laboratory tasks.

This study centered on preschool children (aged 4 to 6), a period in which there are increases in the development of social competence and prosocial behaviors as a result of the emergence of Theory-of-Mind (Wellman, 2002). A comprehensive meta-analysis found that the effect of prosocial content in television programs increased sharply between the ages of 3–7, in conjunction with increases in theory-of-mind and perspective taking abilities (Mares & Woodard, 2005). Since theory-of-mind often matures around the age of five (Wellman, 2002) this study examined age-related differences in prosocial learning from a VR prosocial game.

The findings are mixed with respect to gender. Whereas studies on prosocial video game have not reported significant gender differences (Gentile et al., 2009; Mares & Woodard, 2005), other experimental studies have shown that girls are more influenced by violent video games than boys (Cooper & Mackie, 1986), but boys are more influenced by violent TV content (Paik & Comstock, 1994). In addition, there is extensive empirical evidence indicating gender differences in prosocial behaviors in preschool, with greater prosociality among girls than boys (e.g., Eisenberg & Fabes, 1998; Kirschner & Tomasello, 2010). Given the lack of studies on the effects of gender on prosocial learning from the media in the preschool age, we examined the gender effects in an exploratory manner.

Based on the literature reporting positive associations between prosocial digital and VR game play and prosocial behavior (e.g., Gentile et al., 2009; Gillath et al., 2008), and negative associations between violent digital games and sharing and helping behaviors (Gentile et al., 2014), we hypothesized that:

H1. Participants in the VR prosocial game condition will exhibit more prosocial behaviors (helping and sharing) than participants in the violent, positive affect, or neutral VR game conditions.

H2. Participants in the violent game condition will exhibit the lowest amount of prosocial behaviors than participants in the other game conditions.

H3. Consistent with the literature (Mares & Woodard, 2005), there should be a positive association between child's age and prosocial behavior after the VR prosocial game.

We also specifically examined two possible mediating variables in the VR experience and their effects on subsequent prosocial behavior in the real world: (1) simply experiencing positive affect in the VR prosocial game will lead children to engage in prosocial behavior, and (2) a sense of competence in performing helping tasks in the virtual environment will encourage children to help on unrelated tasks after playing.

2. Experiment 1

In the first experiment, 4- to 6-year-olds were randomly assigned to play a prosocial, a violent, or a neutral VR game. After playing, the children were exposed to four experimental scenarios in which the experimenter needed help, during which their level of helping behavior was measured. The children's sense of competence and positive affect in the VR experience were examined to explore their role in the transference of the prosocial skills from the VR game environment to the real-life settings. Thus, this experiment probed whether VR experiences involving prosocial behavior affected young children's prosocial behavior in real-world contexts.

2.1. Method

2.1.1. Participants

One hundred and sixty-nine children aged 4 to 6 from six preschool classrooms in central Israel participated in this study. Three children did not complete the study and were excluded from the final analyses. The final sample consisted of 166 children (Mean age = 4.95, *SD* = 0.66; 83 boys, 83 girls). Ninety-seven percent of the children were Israeli-born and all the children were Jewish. The participants were randomly assigned to one of the three VR game conditions (stratified according to gender and age group): the prosocial game (n = 56), the violent game (n = 55), or the neutral game (n = 55). Eight percent of the participants (n = 13) had previous experience of VR technology and 82% (n = 136) had used touch screen devices. None had previous experience with the games included in the study.

G-power (v.3.1) software (Faul et al., 2009) was used to obtain an a-priori power analysis to evaluate the number of participants required for each condition. It determined that 111 participants (37 subjects in each condition) were required to obtain an effect size of 0.3 at 80% power and an alpha level of 0.05, based on a previous study on the effects of prosocial digital games on preschoolers (Shoshani et al., 2022). A larger sample was recruited to enhance power.

The two experiments in this study were approved by the institutional review board of *** and by the ethics committee of the Israel Ministry of Education. Informed written parental consent and demographic information were obtained from all parents prior to enrollment in the study. Summary demographic information of the study participants are presented in Table 1.

2.1.2. Procedure and measures

VR Game manipulation. An experimenter met with the children individually in a room adjacent to the preschool classroom. The sessions were video recorded for behavioral coding. The experimenter placed the VR goggles, a Bobovr Z6 Virtual Reality Headset, on the child. This VR headset supports a smartphone size of 4.7–6.2 inches and is equipped with a Samsung Galaxy S20 smartphone. The refraction adjustment

Table 1
Demographic characteristics of the samples.

	Experiment 1	Experiment 2	Comparisons of the two samples	
	N = 166	N = 173		
	Mean (*SD*)	Mean (*SD*)	Statistic	*P Value*
Age (years)	4.95 (0.66)	4.82 (0.56)	$t = 1.95$	.051
Age group				
4-year-olds	84 (50.6%)	87 (50.3%)	$\chi^2 = 0.01$	.95
5-year-olds	82 (49.4%)	86 (49.7%)		
Gender				
Girls, *n* (%)	83 (50%)	86 (49.7%)	$\chi^2 = 0.01$	.96
Boys, *n* (%)	83 (50%)	87 (50.3%)		
Ethnicity				
Jewish, n (%)	166 (100%)	173 (100%)		
Socioeconomic status				
Low SES *n* (%)	27 (16.3%)	30 (17.3%)	$\chi^2 = 0.09$	.96
Middle SES *n* (%)	103 (62%)	107 (61.8%)		
High SES *n* (%)	36 (21.7%)	36 (20.9%)		
Family status				
Married	137 (82.5%)	142 (82.1%)	$\chi^2 = 0.26$	.88
Divorced/separated	25 (15.1%)	28 (16.2%)		
Single	4 (2.4%)	3 (1.7%)		
Children in the household				
1	48 (28.9%)	46 (26.6%)	$\chi^2 = 0.32$	.85
2	92 (55.4%)	97 (56.1%)		
≥3	26 (15.7%)	30 (17.3%)		
Previous VR technology use	13 (8%)	15 (9%)	$\chi^2 = 0.08$	.78
Previous touch screen use	136 (82%)	145 (84%)	$\chi^2 = 0.21$	.64

ranges from −500 to+200°, and the focal adjustment ranges from 2.1 to 2.5 inches/56–70 mm, with a field of angle of 110°. Glasses did not have to be removed since the VR headset fits over prescription eyewear. The participants were randomly assigned to one of the three VR game conditions: neutral, prosocial, or violent. The research assistant selected the correct game prior to VR headset placement. Participants engaged in 5 min of training during which they were shown and practiced the VR game. After the training session, the participants played their respective VR game for 15 min.

Selecting the VR games. Twelve potential VR games were evaluated for possible inclusion in the study. The 12 titles were popular age-appropriate apps from the Google Play app store. The VR games were selected based on their content (neutral, prosocial, or violent for Exp. 1, and a positive affect inducing game for Exp. 2) and their relatively similar characteristics as rated by independent judges (i.e., rewards through gameplay, level of activity, interest, engagement, level of fatigue, ease of use, and simplicity), although some differences in arousal in reaction to the game existed as a result of the different nature of the games.

The games were rated, in a pilot study, by 30 preschoolers and matched in terms of pace (e.g., Do you think that the pace of the game was fast?), engagement (e.g. "You felt like you just couldn't stop playing"), enjoyment (e.g., "You thought the game was fun"), and difficulty of control (e.g., " It was easy to learn how to play the game"), using a pictorial 4-point scale ranging from "not at all" to "very much".

In addition, the pilot study participants rated the level of prosocial and violence content of each app. The items included questions about the levels of harm or injury, killing or shooting at other game characters (3 items, $\alpha = 0.95$), and cooperating, helping, and doing nice things to other game characters (3 items, Cronbach's $\alpha = 0.96$). The prosocial VR game averaged 3.6 for prosocial content, and 1.3 for violence. The violent VR game averaged 3.7 for violence, and 1.4 for prosociality. The neutral VR game had average scores of 1.4 for prosocial, and 1.2 for violent content.

The VR games. In the prosocial condition, the participants played a VR game entitled the "Peronio Pop-Up Book" (Ovni Studios, 2020). This interactive game tells the story of a young preschool boy who is not able to decide what he will be when he grows up. Peronio, the game character, tries out various professions and deals with different challenges and tasks. The players follow him on his journey and help him on various fun and child-friendly challenges and mini-game tasks along the way that provide an opportunity for practicing prosocial behaviors.

For example, when Peronio experiments with being a baker, the players help him bake a cake, and then with cleaning up and putting things away in the kitchen. When Peronio tries out being an engineer the players help him transform his dad's old car into a spaceship by finding all the parts and putting them together to form a new spaceship. When Peronio wants to be an astronaut the players help him find friendly aliens. When Peronio wants to be a dentist the players help him to fix a dragon's crooked teeth and make it brand new braces. Thus, the game offers a variety of prosocial experiences related to giving help, collaborating, and sharing objects. Throughout the game, the player receives positive reinforcement for prosocial behavior. The game is designed for young children and prosocial game characteristics are dominant features of the game tasks.

In the violent condition, the participants played the VR game "EVO VR Infinity Space War" (Merkury Innovations2017 ,) in which the player sits in a shooter rocket ship that flies through space tunnels and needs to shoot enemy ships, protect the spaceship, and dodge asteroids in an immersive 3D, 360-degree space. In the neutral condition, the participants played the VR game "VR Industrial 4.0 City Town 3D" (Bazaar MD Game Zone2017 ,). This game offers a virtual tour of an industrial city town, in which the player walks around the streets and sees different residential buildings and areas of a modern urban city.

Positive affect and competence. The potential mediators were assessed after game play. Competence was assessed using the Perceived Competence Scale (PCS; Williams & Deci, 1996). The PCS is a short 4-item questionnaire that assesses perceived competence for a particular behavior. The items were adapted to the game context. One sample item was: "You felt very capable of helping Peronio". Children responded to each item on a 4-point Likert scale ranging from 1 (not at all) to 4 (very much). The competence score was the average of the four items. The Cronbach alpha for the questionnaire in this study was 0.90.

Positive affect was measured using the five positive-affect items from the Positive and Negative Affect Scale (PANAS) for Preschool Children (Shoshani & Slone, 2017). This measure comprises five adjectives that relate to positive emotions; namely, happy, glad, joyful, excited, and proud. Participants were asked to indicate the extent to which they felt these emotions during the game. Items were rated on 4-point pictorial scale from 1 (not at all) to 4 (very much) and were averaged for the total positive affect score. The coefficient of internal consistency was $\alpha = 0.88$.

Helping behavior. Then, the child's helping behavior was tested using a procedure previously implemented and validated with preschoolers (Bryan et al., 2014). A second experimenter, who was blind to the experimental conditions, gave each participant two highly attractive toys to play with. After 2 min of play, when the participant was thoroughly engaged with the toys, four situations in which the experimenter needed help were presented. In all the situations the experimenter clarified via prompts, as detailed in the procedure protocol, that help was welcome but was not mandatory.

In the first helping task, a bag of rubber bands was "unintentionally" dropped by the experimenter and scattered on the floor. The experimenter started picking the rubber bands up. If the child did not help collecting them, the experimenter prompted by saying "It is difficult to do this alone". In the second task, the experimenter tried to put the rubber bands into a glass jar, and pretended she was having difficulty opening the lid because her hands were full of rubber bands. In the third task, after 10 min of playing with the toys, the experimenter told the child that they would now move on to a drawing activity. The experimenter started collecting the toys from the floor, and the child's assistance was examined. In the final task, the experimenter " accidently"

dropped a pack of crayons and prompted by saying "it is better to pick them up".

Helping coding. The total helping behavior score ranged from 0 to 4 and was based on the number of tasks in which the child helped the experimenter. The child received one point for helping for each of the following behaviors: (a) the child collected at least one rubber band from the floor, (b) the child opened the lid, (c) the child helped pick up at least one toy and put it back in its original place, (d) the child picked up at least one crayon and put it back in the box. Thirty-four percent of the children required the second prompt to assist in the helping tasks. The helping total score was coded after the completion of the study, by two independent coders who were blind to the study hypotheses and the study conditions. The coders were each trained to a reliability of >90% on 30 video-recorded sessions of the pilot study participants. The Kappa statistic for inter-rater reliability was high (kappa = 0.97). Disagreements were resolved by discussion.

Manipulation check. As a manipulation check, after the helping procedure, participants were asked questions about the level of prosocial and violent content in the game they played. The measurement of prosocial game content consisted of three items asking whether the child did nice things, helped, and shared items during playing the game. Another three items assessed violent game content asking whether the child caused damage, killed, or hurt others during the game. The items were rated on a 4-point Likert-type pictorial scale from 1 (not at all) to 4 (very much).

2.2. Results

2.2.1. Descriptive statistics

The means, standard deviations and bivariate correlations for the variables are presented in Table 2. The skewness and kurtosis parameters indicated that the data satisfied the assumption of a normal distribution. Playing a VR prosocial game was significantly correlated with positive emotions, competence, and helping behavior. Girls exhibited more helping behavior than boys. Age was related to greater competence, positive emotions, and helping.

2.2.2. Manipulation check

To confirm that the game manipulation was effective, we tested for differences in the children's perceptions of the level of prosocial behavior and violence in the VR games. A MANOVA was conducted in which the independent variable was the VR game condition (prosocial, violent, and neutral), and the dependent variables were the perceived prosocial and violent behavior in the games. The analysis revealed a significant main effect of VR game condition on the dependent variables: Wilks' $\Lambda = 0.23$, F (4, 324) = 86.80, $p < .001$, partial $\eta 2 = 0.52$.

Children reported higher levels of prosociality in the VR prosocial game (vs. the neutral and violent game conditions): M prosocial = 3.63, $SD = 0.56$, vs. M violent = 2.56, $SD = 1.05$, $p < .001$, and M neutral = 2.48, $SD = 1.16$, $p < .001$; F (2,163) = 25.21, $p < .001$, partial $\eta 2 = 0.24$. In addition, the violence level was rated as significantly higher in the VR violent game, $M = 3.05$, $SD = 0.68$, than in the prosocial, $M = 1.29$, $SD = 0.38$, $p < .001$, and the neutral games, $M = 1.25$, $SD = 0.55$, $p < .001$, F (2,163) = 193.81, $p < .001$, partial $\eta 2 = 0.70$.

Table 2
Means, standard deviations, and bivariate correlations in Exp. 1.

	M	SD	1	2	3	4	5
1. Age	4.95	0.66					
2. Gender (girls)			−.05				
3. VR prosocial game			.04	.01			
4. Competence	2.48	0.59	.23**	−.09	.24**		
5. Positive emotions	3.10	0.79	.23**	.05	.51***	.31***	
6. Helping	1.78	0.99	.30***	.21**	.35***	.11	.33***

Note. $N = 166$. ** indicates $p < .01$; *** indicates $p < .001$.

2.2.3. The effects of the VR games on helping

To examine the effects of the VR games on children's helping behavior towards the experimenter, a 3 VR game condition (prosocial, violent, and neutral) x 2(Gender) analysis of covariance (ANCOVA) was conducted, controlling for age as a covariate. The analysis yielded significant main effects for the VR game condition, F (2, 159) = 17.56, $p < .001$, partial $\eta 2 = 0.18$, gender, F (1, 159) = 11.62, $p < .001$, partial $\eta 2 = 0.07$, and age, F (1, 159) = 16.63, $p < .001$, partial $\eta 2 = 0.10$, on helping behavior. The game × gender interaction with prosocial behavior was not significant, F (1, 159) = 11.62, $p = .08$, partial $\eta 2 = 0.03$.

Post-hoc Bonferroni comparisons showed that children in the prosocial game condition helped the experimenter significantly more ($M = 2.27$, $SD = 0.86$) than children in the violent game ($M = 1.27$, $SD = 0.71$, $p < .001$, $d = 1.47$) or the neutral game conditions ($M = 1.80$, $SD = 1.10$, $p = .01$, $d = 0.48$). The latter conditions also differed significantly ($p = .01$), with the lowest level of prosocial behavior among children who played the violent VR game. Girls ($M = 1.99$, $SD = 0.97$) helped the experimenter on significantly more tasks than boys ($M = 1.58$, $SD = 0.96$, $p = .007$, $d = 0.43$). Prosocial behavior after the VR games increased with age ($r = 0.30$; $p < .001$).

2.2.4. Mediation effects of positive emotions and competence

We next investigated whether the effect of the VR prosocial game on helping behavior was mediated by positive emotions and/or sense of competence following the game play. We conducted a parallel mediation analysis, using 5000 bootstrap samples (PROCESS 3.5, Model 4; Hayes, 2013) with helping behavior as the dependent variable, VR prosocial game play as the independent variable and positive emotions and competence as the mediators (see Fig. 1). As expected, VR prosocial game play was positively associated with positive emotions ($B = 0.51$; $SE = 0.07$, $p < .001$) and competence ($B = 0.24$; $SE = 0.08$, $p = .002$). Positive emotions were positively related to increased helping behavior ($B = 0.20$; $SE = 0.09$, $p = .02$), but competence was not significantly related to helping ($B = -0.01$; $SE = 0.08$, $p = .89$).

The analysis indicated that positive emotions mediated the relationship between the prosocial play and helping ($B = 0.10$, $SE = 0.05$, 95% CI = 0.0198–0.2096). The associations of prosocial play with helping ($B = 0.25$; $SE = 0.08$, $p = .003$) was still significant after controlling for positive emotions, suggesting that positive emotions partially mediated the link between VR prosocial play and prosocial behavior. However, sense of competence did not mediate the relationship ($B = -0.01$, $SE = 0.02$, 95% CI = −0.0430–0.0360).

2.3. Discussion

These findings suggest that preschool children's helping behavior was affected by playing prosocial VR games. The results also showed that playing a violent VR game led to the lowest helping in comparison to the other conditions. These findings point to the influence of both prosocial and violent content in VR games on children's prosocial behavior as early as at the age of 4.

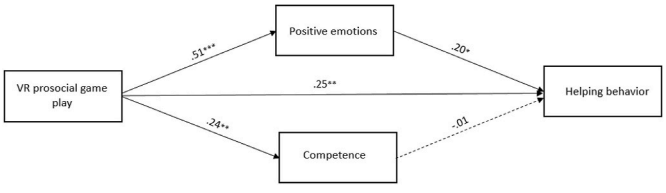

Fig. 1. The direct and indirect effects of VR prosocial game play through positive emotions and competence on helping; ***$p < .001$, **$p < .01$, *$p < .05$.

The findings also suggested that positive affect mediated the effect of VR prosocial play on helping, whereas the effect of competence was not significant. This is consistent with the well-established relationship between positive emotions and prosocial behavior (Aknin et al., 2012). However, these findings do not indicate the extent to which the prosocial behavior in this study stemmed from the prosocial content of the game itself or from the positive emotions associated with it.

3. Experiment 2

The first experiment provided evidence that engaging in a prosocial VR game increased preschoolers' helping behavior towards the experimenter in an experimentally controlled setting. However, it remained unclear whether the prosocial responses observed in the first experiment could generalize to real-life contexts involving peers rather than adults, or whether they stemmed merely from compliance with demands or desirability concerns (Engelmann et al., 2012). Studies have shown greater prosocial behavior among preschoolers when directed toward an adult than toward another peer, perhaps as an indication of greater compliance in the preschool years with adults (Beilin, 2013). It remained unclear whether the observed prosocial behaviors in Experiment 1 would actually occur in natural daily settings and could be generalized to conditions involving peers.

We next examined whether the prosocial effects of the prosocial game condition would extend to sharing behavior (i.e., a different type of prosocial behavior that preschool children exhibit during social interactions with peers), which generally involves more cost to the child. Eisenberg-Berg and Hand (1979) claimed that young children's sharing behaviors, which entail a cost to the children, are more other-people oriented than helping, which generally involves less cost or is done merely to comply with adults' requests.

Finally, in the first experiment, positive emotions were identified as a significant mediator of the influence of the VR prosocial game on prosocial behavior after the game. In the second experiment, we manipulated positive emotions in the VR environment by using a positive affect game to assess the added value of a prosocial game over other games that generate positive emotions. Specifically, we sought to test whether a prosocial game would be significantly more effective than a game that elicited positive emotions in terms of motivating prosocial behavior.

To examine these issues, we recruited a new sample of preschool children aged 4–6 years, and employed a similar procedure to Exp. 1, with three exceptions. First, the participants' prosocial behavior after the VR experience was directed towards peers from the preschool class and not an adult. Second, we examined the prosocial effect of the game conditions on sharing behavior. Third, positive affect rather than the violent condition was manipulated to explore the differential effects of the VR game conditions (prosocial, positive affect, and neutral) on prosocial behavior.

Based on previous studies on prosocial video games, it was hypothesized that the prosocial game would lead to significantly greater sharing behavior than the positive affect and neutral conditions, due to greater prosocial practice opportunities, rewards for prosocial acts, and prosocial modeling (Gentile et al., 2014; Greitemeyer, 2022).

In addition, based on studies reporting associations between positive emotions and prosocial behavior (Aknin et al., 2018; Fredrickson, 2004), it was hypothesized that the participants' greater positive emotions in the positive-affect game condition would lead to more sharing behavior than in the neutral condition.

3.1. Method

3.1.1. Participants

One hundred and seventy-five children aged 4–6 years from six preschool classrooms in central Israel participated in this study. Two children did not complete the study and were excluded from the final analyses. The final sample consisted of 173 children (Mean age = 4.82, *SD* = 0.56; 87 boys, 86 girls). Ninety-seven percent of the children were Israeli-born and all the children were Jewish. Participants were randomly allocated to one of the three VR game conditions (stratified according to gender and age group): a prosocial game (n = 57), a positive affect game (n = 57), or a neutral game (n = 59). Nine percent of the participants (n = 15) had previously used VR technology and 84% (n = 145) had used touch screen devices. None of the participants had previous experience with the games used in this study.

G-power software (v.3.1; Faul et al., 2009) was used to provide an a-priori power analysis to determine the number of participants required for each condition. It showed that 111 (37 subjects in each manipulation condition) were required to obtain an effect size of 0.3 at 80% power and alpha level of 0.05, based on a previous study (Shoshani et al., 2022). A larger sample was recruited to enhance power. Informed written consent and demographic information were obtained from all parents (see Table 1).

3.1.2. Procedure and measures

VR Game manipulation. The experiment was carried out in a quiet room in the children's preschool. The procedure began with the VR game manipulation, which was similar to that of Exp. 1 except that instead of the violent condition children were assigned to a VR game that evoked positive emotions. Thus, the participants were randomly allocated to one of the three VR game conditions: the prosocial game (Peronio Pop-Up Book; Ovni Studios, 2020), the positive affect (Relax River VR; Polyrawdevelopment2018 ,), or the neutral game (VR Industrial 4.0 City Town 3D; Bazaar MD Game Zone2017 ,). Relax River VR is a virtual reality simulation of calmly floating down a river in a kayak through picturesque scenery of trees, mountainous areas, and waterfalls. Beautiful butterflies hover over the kayak, and birds sing and circle around. The participant controls the kayak speed and can change the point of view of the landscape. In a pilot study, the Relax River VR game had average scores of 1.7 for prosocial content, and 3.6 for positive affect, using a pictorial 4-point scale ranging from "not at all" to "very much". Participants started with a 5-min training period and then played the game for 15 min. Positive affect and competence were assessed after the game as potential mediators on the same measures as at Exp. 1.

Sharing behavior. Participants' sharing behavior was measured using the dictator game (Gummerum et al., 2010). Ten identical stickers and two envelopes were spread out in front of the child. The participants were asked to determine how to allocate the 10 stickers between themselves and an unknown peer from the children in their preschool. Stickers they wished to keep for themselves were put in an envelope bearing the name of the participant, and the stickers for the other child were placed in an unlabeled envelope. The experimenter confirmed the participants' understanding of the task by asking quiz questions from the measure's administration protocol. Then, to avoid experimenter bias and to give the participants privacy, the experimenter turned around and the participants distributed the stickers. At the end of this task, the experimenter gave the participants their envelope. The number of stickers that were allocated to the other child served as the dependent variable. Benenson et al. (2007) showed that stickers are highly desirable and valued by preschool children and are therefore an appropriate resource for the dictator game with players in this age group.

Manipulation check. As a manipulation check, after the sharing procedure, participants were asked questions about the level of prosocial content in the game they played, using the same items as in Exp. 1.

3.2. Results

3.2.1. Descriptive statistics

The means, standard deviations and bivariate correlations for the variables are presented in Table 3. The data satisfied the assumption of a normal distribution according to skewness and kurtosis parameters. Playing a VR prosocial game was significantly associated with positive

Table 3
Means, Standard Deviations, and Bivariate Correlations in Exp. 2.

	M	SD	1	2	3	4
1. Age	4.82	0.56				
2. Gender (girls)			−.01			
3. VR prosocial game			.04	.02		
4. Positive emotions	3.26	0.83	.27***	.10	.27***	
5. Competence	2.81	0.61	.21**	−.05	.23**	
6. Sharing	3.62	2.34	.23**	.10	.28***	.42***

Note. $N = 173$. ** indicates $p < .01$; *** indicates $p < .001$.

emotions, competence, and sharing behavior. Age was related to greater positive emotions, competence, and sharing.

3.2.2. Manipulation check

As a manipulation check, a MANOVA was conducted with VR game condition as the independent variable, and the children's reports of the level of prosocial behavior and positive affect during the VR game play as the dependent variables. The analysis revealed a significant multivariate main effect for condition: Wilks' $\Lambda = 0.42$, F (4, 338) = 46.40, p < .001, partial $\eta 2 = 0.35$.

Univariate follow-up analyses indicated a significant effect for game condition on perceived prosociality. The prosocial game was perceived as more prosocial ($M = 3.85$, $SD = 0.33$) than the positive affect game ($M = 2.17$, $SD = 1.18$, $p < .001$) and the neutral game ($M = 1.75$, $SD = 0.89$, $p < .001$), F (2,170) = 93.53, $p < .001$, partial $\eta 2 = 0.52$. The manipulation check for positive affect revealed that children reported more positive emotions after the pro-social game ($M = 3.57$, $SD = 0.64$) and the positive affect game ($M = 3.45$, $SD = 0.66$) compared to the neutral game ($M = 2.78$, $SD = 0.91$, $ps < .001$), F (2,170) = 18.87 $p <$ .001, partial $\eta 2 = 0.18$, with no significant differences between the prosocial and positive affect conditions ($p = .64$).

3.2.3. The effects of the VR games on sharing behavior

To examine the effect of the VR game manipulation on children's sharing behavior, a 3 VR game condition (prosocial, positive affect, and neutral) x 2(Gender) analysis of covariance (ANCOVA) was conducted, controlling for age as a covariate, and the sharing score (i.e., the number of stickers that children shared) as the dependent variable.

The ANCOVA yielded significant main effects for the VR game condition, F (2, 166) = 7.32, $p < .001$, partial $\eta 2 = 0.08$, and age, F (1, 166) = 7.70, $p = .006$, partial $\eta 2 = 0.04$, on children's sharing scores, but not for gender, F (1, 166) = 2.02, $p = .15$, partial $\eta 2 = 0.01$. In addition, no significant interaction between gender and game condition was found, F (2, 166) = 0.23, $p = .79$, partial $\eta 2 = 0.003$.

Post-hoc Bonferroni comparisons revealed that children in the VR prosocial condition shared more stickers ($M = 4.56$, $SD = 2.24$), than in the positive affect ($M = 3.42$, $SD = 2.56$, $p = .02$, $d = 0.48$) and neutral conditions ($M = 2.92$, $SD = 1.93$, $p < .001$, $d = 0.79$). The differences in sharing scores were not significant between the positive affect and neutral conditions ($p = .44$). Sharing behavior after the VR games increased with age ($r = 0.23$; $p = .003$).

3.2.4. Mediation effects of positive emotions and competence on sharing

The PROCESS 3.5 macro for SPSS (Hayes, 2013) was used to examine whether children's positive emotions and/or sense of competence following the VR game mediated the association between the VR prosocial game and children's sharing. For this purpose, a mediation analysis (PROCESS 3.5, Model 4), using 5000 bootstrap samples with sharing behavior as the dependent variable, VR prosocial game play as the independent variable and positive emotions and competence as the mediators was tested (see Fig. 2). As expected, the VR prosocial game play was positively associated with positive emotions ($B = .27$; $SE = 0.07$, $p < .001$), and competence ($B = 0.23$; $SE = 0.07$, $p = .002$). Positive emotions were positively related to sharing behavior ($B = 0.37$; $SE = 0.07$, $p < .001$), but not competence ($B = -0.04$; $SE = 0.07$, $p = .57$).

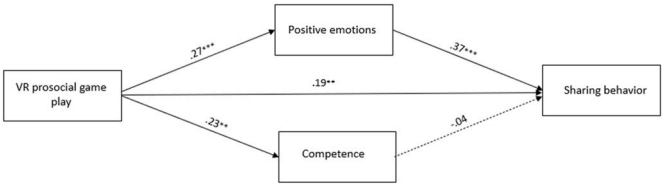

Fig. 2. The direct and indirect effects of VR prosocial game play through positive emotions and competence on sharing; ***$p < .001$, **$p < .01$.

In addition, positive emotions mediated the relationship between the prosocial play and sharing ($B = 0.10$, $SE = 0.03$, 95% CI = 0.048–0.155). These results support a partial mediation effect, given that the prosocial play was still a significant predictor of sharing even after controlling for the mediator of positive emotions ($B = 0.19$; $SE = 0.07$, $p = .009$).

3.3. Discussion

These findings suggest that VR prosocial game play motivates preschoolers' sharing behavior towards peers. Children in the prosocial condition shared more stickers than children in the control conditions. Most children in the prosocial condition shared half or a little less than half of their stickers with their friends. In the other conditions, the children treated their preschool classmates in a more selfish manner and kept more stickers for themselves than they shared with others.

The results indicated a positive association between age and sharing. This concurs with other studies that have reported increased egalitarian sharing with age during the preschool years, which coincides with the premises of maturation of theory-of-mind that suggests a growing ability to understand the mental states of others (Samek et al., 2020; Yu et al., 2016).

The findings also suggest that the prosocial effect of the prosocial game was more pronounced compared to that of positive mood game on sharing. The findings also demonstrate, as in the first experiment, that positive emotions explained part but not all of the differences between conditions. Positive affect was found to be a partial mediator between the prosocial game play and sharing. However, in contrast to the study hypothesis, the VR game that evoked positive emotions and did not include prosocial content did not significantly increase sharing behavior. These findings highlight the potential of VR prosocial environments to specifically foster prosocial learning.

4. General discussion

Young children's social learning often takes place within their families, preschools, and immediate social contexts, through interactions with peers and trusted adults. Our findings suggest that using VR technology with preschool children may be appropriate for favorable social experiences that can leverage virtual contexts for prosocial learning. Children in the VR prosocial condition demonstrated significantly higher levels of helping and sharing behaviors compared to the violent, positive affect, and control conditions. These increases in prosocial behavior, both towards adult stranger and peers, suggest that prosocial behavior was strengthened and sustained via the VR immersive technology.

The depth cues offered by the VR games, together with head tracking, signaled to the children that the VR environment is a physical space they could navigate in a similar way as in real life. Thus, interacting with Peronio in the VR prosocial environment could have been very similar to playing with another child in person. However, it is worth noting that virtual reality also gives children the opportunity to behave differently from real-life same circumstances (Bezruchko & Anikina, 2021). The prosocial game in this study simulated an open non-judgmental, non-threatening social context in which the child could engage and practice various kinds of cooperation, such as helping,

sharing, and kindness, and receive positive reinforcements for these behaviors. Thus, the VR environment can expand social behaviors, and give some children the opportunity to become someone else, which in fact creates a unique and powerful space for developing social skills.

The VR environment also offered high levels of personal involvement, engagement, and presence that may have contributed to the participants' prosocial learning (Araiza-Alba et al., 2020). The prosocial VR game included highly realistic 3D objects and game characters set in ecologically valid settings such as home and neighborhood environments. In addition, the real-time social interaction and the visual and auditory feedback from the game characters may have contributed to a sense of realness and immersion in the social situations. Thus, the VR technology stimulated the children's senses and presented social information in a very realistic manner. This level of realism brought about by direct immersion in a social situation can create high engagement and learning (McMahan, 2003). Thus, the social content presented through VR is likely to have been highly attractive and engaging for children, thus leading to high social learning.

Furthermore, the VR head-mounted display tracked the children's head movements so that the game images and participants' movements changed in a natural way in the three-dimensional social environment with head motion, thus allowing for a sense of presence and immersion (Maples-Keller et al., 2017). This sense of presence in VR has been associated with increased social learning (Dede, 2009). However, more studies are needed to compare the social effects of VR learning environments with other digital technologies such as touch screen tablets and traditional desktop computers.

Our findings suggest that experiences in VR games may impact young children's in-the-moment prosocial behavior, as well as foster the transfer of game behavior to the real world. While studies with adults have shown that players transfer prosocial behaviors from the VR environment to real life social contexts (Rosenberg et al., 2013), less is known about how preschool children transfer VR prosocial content. Our results suggest that young children may transfer their positive social experiences of helping and sharing in VR games to the physical world. The children who played the prosocial game exhibited higher levels of helping behavior towards the experimenter and sharing behaviors towards their peers than the children in the violent, positive affect or neutral-game conditions. However, our results also indicate that playing a violent VR game can also negatively influence young children, who engaged in less helping behavior towards the experimenter in the transition from game to reality than children in the prosocial and neutral-game conditions.

One important contribution of this study was its examination of possible mediating mechanisms of VR prosocial game play on subsequent prosocial behavior.

The results indicated that the significant variance in children's prosocial behavior after the VR prosocial game could be explained by increases in positive emotions. Fredrickson (2004) stressed that positive emotions signal and encourage advantageous behaviors early in life. Rewarding emotions creates a positive feedback loop in which the emotional rewards experienced from engaging in prosocial acts motivate subsequent prosocial actions (Aknin et al., 2018).

However, the positive emotions that resulted from the VR positive-affect condition did not produce a similar increase in prosocial behavior as the prosocial game. These findings underscore the need to consider more specific positive emotions and other mediating mechanisms in future studies. Although many positive emotions have been related to prosocial behavior (Fredrickson, 2004), previous studies have shown that prosocial emotions such as empathy, gratitude, and pride may be unique in that they elicit prosocial behavior even when costly to the individual (e.g., Aknin et al., 2018; Bartlett & DeSteno, 2006; Tsang, 2006). Prosocial thoughts should be taken into consideration as well, in light of the increasing literature indicating that the effect of prosocial video gaming on helping is mediated by the increased accessibility of prosocial thoughts (Greitemeyer & Osswald, 2010).

4.1. Limitations

This study has a number of limitations. The generalizability of our findings to children's real-life contexts is unclear. There are differences between the measurement of prosocial behaviors in laboratory settings and the actual world that might affect how a child behaves. For example, it is possible that children's helping and sharing behaviors in this study were derived from social desirability or reputational concerns. Further research should consider measurement of prosocial behavior in children's natural social settings.

The prosocial VR game in this study included a short background story about a child who cannot decide what he wants to be when he grows up. Children may perceive the dilemma of choosing a future profession as extremely remote which may make this theme too abstract and difficult for young children to grasp. Future research would benefit from employing prosocial games that adhere more closely to children's lives. In addition, there were possible differences between the experimental game conditions in this study which extend beyond the obvious differences in their main content (e.g., prosocial, positive affect, violent, or neutral). These could be related to different game features such as graphics, pace, arousal, realism, character gender and enjoyment. Future research using more controlled VR game environments could further examine these results.

Tracking sensors were not used in this study to measure children's prosocial behaviors during the game. Future studies could use VR devices that can capture users' head and body movements and track eye movements to assess children's approach behaviors and attention. This would provide a more fine-grained assessment of prosocial behavior during the game. Another limitation is that self-report measures were used to assess positive emotions and competence after game play. Future studies could employ various assessments of emotional, physiological, and behavioral responses during the actual virtual experience.

This study examined children's sense of prosocial competence during game play as possible mediating variable on the effects of the VR prosocial game on subsequent prosocial behavior. However, studies have associated more general self-perceived prosocial competence with prosocial behavior, and future studies should consider this as a potential outcome of prosocial game play. The fact that empathy and prosocial thoughts were not examined as potential mediators constitutes yet another limitation.

The exclusion of the violent game condition from the second study, although it yielded valuable findings in the first experiment by showing that playing violent VR games decreases prosocial behaviors, prevented the replication of these findings. The sharing task in the second study that focused on an anonymous peer who was not present in the room could have affected the reliability of the procedure. A more ecologically valid prosocial task using a possible confederate peer should be considered in future studies. Finally, the children in this study experienced exposure to one brief VR game, but the long-term effects of VR games on children's social behaviors remain unclear.

4.2. Implications and conclusion

By investigating the effects of VR technologies on children's social behaviors, the findings provide potential opportunities and insights for the future usage of digital VR devices for young children. Virtual education platforms have increasingly become a common feature in young children's preschools and learning environments, and VR platforms are likely to be harnessed by educational institutions and companies to foster children's early social and emotional learning. As VR technology evolves, understanding how to navigate contents and activities in VR platforms may be a significant future skill for children. Understanding the impact of VR on child development will yield insights on which immersive features and virtual experiences are appropriate for children at different ages. This rich information can be utilized for the development of age-appropriate VR environments that can best facilitate both

social and academic learning in preschool and home settings.

CRediT authorship contribution statement

Anat Shoshani: Conceptualization, Methodology, Project administration, Investigation, Formal analysis, Writing - original draft.

Data availability

Data will be made available on request.

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