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Engaged in play: Seven-year-olds' engagement with the play frame when playing with toy figures and their engagement with the fictional world of a video game

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ABSTRACT

Children's engagement in fictional worlds created when playing with toys and video games has received little research attention. We explored whether children's engagement with the play frame when playing with toy figures was associated with their engagement with the virtual world in a video game in a community sample of 251 seven-year-olds ($M = 6.95$ years, $SD = 0.38$, 44 % girls). Using observational coding, we found that children's engagement with the play frame by enacting roles 'within' the fictional world was positively associated with engaging with the virtual world in the video game. We also found that child characteristics, particularly children's sex and their propensity to talk during play, were associated with their engagement in the two forms of play, and explained the associations in engagement between play contexts. These findings are discussed in terms of the features of the two contexts of play and how they promote children's engagement with the fictional worlds.

1. Introduction

When children play, they create fictional worlds in which they become engaged (Harris, 2000; Lillard, 2013). In pretend play, the fictional world created is referred to as the *play frame* (Kane & Furth, 1993), and children differ in the extent to which they engage with it (Scarlett & Wolf, 1979). Analogously, when playing video games children vary in their *immersion*: their cognitive and emotional engagement with the fictional world of the game (Cairns et al., 2014). Concerns have been raised that technologies such as video games are detrimental to children's imagination, both in the mainstream media (e.g., Bernstein, 2016) and from academic voices (Valkenburg, 2001). Therefore, there is need for more research directly exploring whether children's imaginative engagement with the play frame during pretend play is associated with their engagement with the fictional virtual world in a video game (Calleja, 2011; Harris, 2000).

1.1. Children's engagement with the play frame when playing with toys

In both social and non-social play, engagement in the play frame has been captured by children's behaviour and speech as varying

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from 'within-frame' to 'out-of-frame.' Within-frame speech and behaviour includes: (1) *enactments* of character roles through speech (e.g., *"Mommy, I did something nice for you. I made you a wedding cake,"* Giffin, 1984, p. 81; Davis et al., 2013; Howe et al., 1998, 2014; Rydland, 2009; Sawyer, 2017) or physical action, moving the toys in a way reflecting such roles (e.g., moving a toy's legs to make it 'walk' across a table, Howe et al., 1998, 2014); (2) *narration* of stories (e.g., *"…then the king and queen runned,"* Scarlett & Wolf, 1979, p. 38; Gardner, 1980; Giffin, 1984); (3) *management* of the pretend scenario (or *metacommunication*; Bateson, 1955, e.g., *"I'm calling her gramma,"* Giffin, 1984, p. 83; Davis et al., 2013; Krafft & Berk, 1998; Sawyer (2017)). Children may also choose not to engage within the play frame at all (Auwärter, 1986; Giffin, 1984; Howe et al., 2014; Krafft & Berk, 1998). Therefore, children vary in how engaged in the play frame they are.

1.2. Children's engagement in the fictional world of a video game

An analogous experience of engaging in an imaginary world during play has been noted when children play video games, in terms of their *immersion* in the fictional world of the game (Cairns et al., 2014; Harris, 2000; Liao & Gendler, 2011). Immersion has been studied in both adults and children, defined as the degree of cognitive and emotional involvement that players have with a video game (Cairns et al., 2013, 2014; Jennet, 2010; Przybylski et al., 2010). This definition aligns with concepts such as *transportation: "the extent that individuals are absorbed into a story or transported into a narrative world"* (Green & Brock, 2000, p. 701); *absorption* in imaginary activities (Harris, 2000; Liao & Gendler, 2011), *presence*, the subjective experience of being within the fictional or virtual environment (van den Hoogen et al., 2009), and the use of *engagement* as reflecting that the terms such as the above generally represent *"ever deeper engagement in game-play"* (Brockmyer et al., 2009, p. 624). In the present paper, we draw on these different literatures to examine the similarities in the engagement with the fictional and imagined world during toy play and video game play.

Theorists differ in whether they consider the experience of immersion to be progressive, wherein individuals proceed through stages of immersion in a linear order (i.e., becoming engaged, engrossed and then experiencing total immersion; see Brown & Cairns, 2004; Jennet et al., 2008), or whether immersion is a result of factors related to both the presentation of the video game and a player's engagement with the narrative and characters in the game (Calleja, 2011; Calleja et al., 2016; Ermi & Mäyrä, 2007). However, both perspectives share similarities in the factors that are important to immersion in a video game environment. Firstly, an important component of becoming immersed in a game is a player learning to navigate the environment and enjoying the presentation and playing of the game. Secondly, playing the game results in emotional reactions for players, including empathy with characters in the game and the avatar the player controls. Finally, immersion can involve becoming less aware of the real-world environment as individuals become more immersed in their game play (Brown & Cairns, 2004; Calleja et al., 2016; Calleja, 2011; Ermi & Mäyrä, 2007; Jennet et al., 2008).

Although most of the research investigating immersion has focused on adults, researchers have explored children's experience of immersion using different methods. Self-report questionnaires (e.g., Brockmyer et al., 2009; Cheng et al., 2017; Norris et al., 2014; Piotrowski & Meester, 2018) and interviews (e.g., Hannaford, 2012) have often been used with children and adolescents aged 11–14 to capture their immersion. However, if as some theories suggest (Brown & Cairns, 2004; Jennet et al., 2008), immersion is a process that dynamically increases over the course of play as individuals progress through stages, then questionnaire and interview methods can be criticised in that they assess children's immersion retrospectively after having played the game. Therefore, self-report data could be inflated as a reflection of the point at which children have experienced the greatest degree of immersion.

In contrast, observational methods assess children's experience of immersion throughout their game play. However, there is consistency across the two methods. Observed behaviours identified as reflecting immersion do correlate with questionnaire measures of immersion (von der Pütten et al., 2012), and corroborate previous questionnaire data showing that the time spent playing the game and performance were related to a greater experience of immersion (Martinovic et al., 2016). This suggests that observational methods can be reliably used to study children's immersion over the course of a game.

1.3. Similarities and differences between engagement with the fictional worlds when playing with toys and video games

Although children's immersion in computer games has been successfully measured, little attention has been paid to exploring children's engagement in the virtual world of video games in relation to their engagement with the fictional worlds in other types of play. Understanding more about the association between video game play and pretend play with toys speaks to ongoing arguments that playing video games should be viewed as a way of playing that is similar to other forms of play in middle childhood (Lillard, 2014; Singer & Singer, 2005, 2013).

The two forms of play have rarely been studied together in the same age group. Pretend play emerges at around 12–18 months of age, reaches a peak between three to five years, and is now acknowledged to persist into adulthood (see Lillard, 2014, 2017 for reviews). Pretence is conceptualised as an imaginative activity in which children represent and alter reality. They create and enact the roles of fictional characters and create and narrate elaborate plot lines (Lillard et al., 2013; Singer & Singer, 2013).

In contrast, video games are considered to be a form of *games with rules*, and are sometimes seen as dissimilar to imaginative play because of the presence of these rules (Rubin et al., 1983). Games with rules emerge in the primary school years and reach a peak between seven and eleven years (Piaget, 1962; Singer & Singer, 1990; Vygotsky, 1967). Video games are regulated by explicit rules in a similar way to other rule-based games such as board games, playground games or games such as chess, though in the case of the latter these rules are often handed down from previous generations, or by temporary agreement (Garvey, 1991; Piaget, 1962; Rubin, 2001; Valkenburg, 2001).

Despite the view that pretend play and games with rules are different, games with rules, including video games, do feature imagined situations that often incorporate imagined premises (Singer, 1973; Vygotsky, 1967). Rather than seeing these two activities as completely distinct types of play, some investigators argue for a conceptualisation of play as a spectrum, ranging from unstructured free play at one end, with more guided games and structured play at the other (Zosh et al., 2018). In imaginative play in middle childhood, children may set their own rules with respect to the characters and activities in their fictional worlds.

Children regard both toy play and video games, particularly those that include narratives and characters, as imaginative activities (Downey et al., 2007; Søndergaard, 2013), and increased engagement with the fictional or virtual worlds in both types of play has been linked with imagination. For example, children's absorption in play and fantasies is considered an aspect of imagination (Harris, 2000), which is associated with activities such as having an imaginary companion (Kidd et al., 2010) as well as being an item on a teacher-rated 'imaginativeness scale' (Tower, 1985). In interviews, children themselves report that it is imagination that is crucial for their immersion in video game play (Hannaford, 2012; Søndergaard, 2013).

In both pretend play (Harris, 2000) and video game play (Calleja, 2011), imagination allows children to mentally detach from the real world and engage within the fictional worlds that both types of play take place within (Lillard, 2013). For example, when some children play, they react to the fictional world as if the events are really occurring, as shown by their emotional and physical reactions to the content (Cairns et al., 2014; Harris, 2000). Harris (2000) hypothesised that children imagine themselves within the fictional world, adopt a perspective within it and process events from this 'simulated' perspective (Harris, 2000). A similar process is thought to occur when children appreciate the thoughts, feelings, and desire of others, in that they adopt the perspective of the other and imagine their own mental states from that position (Bartsch & Wellman, 1995; Goldman, 2006; Harris, 2000). Indeed, in both contexts of play children demonstrate their appreciation for the internal worlds of the imaginary, virtual or fictional characters by referring to their inner states (Hashmi et al., 2021; Hashmi et al., 2022). Therefore, we expected to find associations in children's engagement with the play frame and virtual world of a narrative-driven video game not only because of the conceptual overlap between the two experiences, but because of the role of imagination in promoting engagement with the fictional worlds of both types of play.

However, while engagement with the fictional world of the play frame and the virtual world of the video game are similar, and the contexts of toy play and video game play are analogous, they are not identical. For example, when playing with toys children have opportunities to adopt multiple roles that are both 'in' and 'out' of the play frame (Scarlett & Wolf, 1979). In contrast, when playing video games, particularly those with characters and a narrative, children often experience the game in a protagonist's role, such as the avatar that the child is controlling (Klimmt et al., 2009); however, the children may still adopt perspectives that are 'in' and 'out' of the virtual world of the game (Hashmi et al., 2021; Hashmi et al., 2022). Furthermore, free play with toys is 'open-ended' with the pretend scenario created by the child (Lillard, 2013; Weisberg, 2013). In contrast, although the virtual worlds elicited from video games are still fictional, in that the world represented is not the real one (Lillard, 2013), the game environments and scenarios have been created by external individuals, not the child. Given these differences in the play contexts, the focus of the present paper is not in directly comparing children's play with toy figures and video games, but in exploring similarities and differences in children's engagement in the fictional worlds of the play.

1.4. Factors that might influence children's engagement with the fictional worlds in different types of play

1.4.1. Gender differences

Some research has found gender differences in relation to the creation of complex imagined worlds (sometimes referred to as *paracosms*; Cohen & MacKeith, 1991; Root-Bernstein & Root-Bernstein, 2006; Taylor et al., 2020). When playing with toys, girls are more likely to speak in the first and second person, whereas boys more often adopt a third person viewpoint (Wolf et al., 1984). However, this may be a result of children's preference for gender-matched toys (Ruble et al., 2006), resulting in differences in play styles. For example, Howe et al. (2020) have found that children demonstrate more creative pretend play when playing with more open-ended toys (e.g., a village set) than when playing with toys that afford a particular scenario (e.g., a train set), the latter of which are traditionally more gendered as being for boys. Therefore, it may be that parents of boys more readily buy gender-stereotypical 'boy toys' that are less likely to promote pretend play.

With respect to video games, although much of the adult literature reports no significant gender differences in immersion (Brockmyer et al., 2009; Byun & Loh, 2015; Kothgassner et al., 2018; von der Pütten et al., 2012), boys do appear to spend more of their free time playing video games than girls do (Gentile, 2009; Rideout et al., 2013), resulting in boys having more experience with those games. This in turn may facilitate greater immersion with boys more likely to develop the ability to functionally play video games, e.g., knowing how to use the controls (Calleja et al., 2016).

1.4.2. Cognitive skills

Children's cognitive skills may also influence children's engagement with the fictional world of one or both play activities. *Inhibitory control* may enable children to inhibit real world surroundings and concepts in order to maintain the imagined components of the play frame and immerse in the video game (Carlson et al., 2014; Pierucci et al., 2014). In addition, *cognitive flexibility* may allow for the appreciation of the perspectives of imagined or virtual others and the ability to move in and out of the play frame to manage the play (Carlson & White, 2013; Giffin, 1984). Furthermore, *working memory* may enable children to retain information regarding the fictional worlds and to draw on past experiences to create the imagined world (Pierucci et al., 2014).

1.4.3. Language skills

Language skills might also influence engagement with the fictional world in each type of play. Children's verbal ability may have a particular influence on children's engagement with the play frame insofar as language is important in structuring and accompanying play. Therefore, children with more advanced language skills may draw upon a larger vocabulary to create and play in elaborate and engaging scenarios (Davis et al., 2013; Engel, 2005; Garvey, 1991; Krafft & Berk, 1998; Sawyer, 2017). Therefore, we tested whether children's sex, executive function skills and language ability were associated with the degree of children's engagement with the fictional worlds when playing with toys and a video game.

1.5. Aims of the study

In the present study, we analysed data available from a British community sample of 7-year-olds, which had been shown to be nationally representative on sociodemographic factors. The assessments included two play tasks, one where children played with toy figures and another where they played a bespoke first-person video game that had been designed in the context of a study of children's prosocial behaviour and aggression, as well as tasks that measured cognition and language. The study design provides opportunities to address questions regarding children's engagement with the fictional worlds during toy play and when playing a video game. To our knowledge, there have been no previous studies investigating whether children's engagement with the fictional worlds of these two types of play are associated with each other, whilst controlling for potential covariates. First, we aimed to use video recordings to devise measures of and describe patterns in children's engagement with the play frame when playing with toy figures and engagement with the virtual world (immersion) when playing a video game. Separate coding schemes for each context of play were developed based upon the two respective literatures. The coding schemes produced independent measures that allowed for an investigation of associations, whilst still capturing the rich detail that was shared in both types of play as well as the unique features of each. Second, we aimed to investigate the child-related factors of children's sex, prior experience with video game play, cognitive skills, and language skills that may be associated with children's engagement with the fictional worlds of the game and the toy play. Finally, we aimed to explore whether children's engagement with the fictional world of the toy play was associated with the same children's engagement with the virtual world of the video game, while controlling for relevant child-related factors.

2. Method

2.1. Design

The Cardiff Child Development Study (CCDS; Hay et al., 2021) is a prospective longitudinal study of first-time parents (mothers and 86 % of the biological fathers) and their children. Three hundred and thirty-two parents were recruited from the South Wales area during the third trimester of pregnancy, and the families were followed up when the children were a mean age of 6, 12, 21, 33 and 84 months. There were no set exclusion criteria, except in the case of miscarriage, the infant's death, or the infant's experience of such severe health problems that it would not be possible to participate in the study. Translators were employed for families whose native

Table 1
Sociodemographic characteristics of the Cardiff Child Development Study (CCDS).

	Full sample of the CCDS ($N = 332$)	Sub-sample of the CCDS ($n = 251$) explored in the present study
Age at first birth *(mean)*		
Mother	28.15 *(SD 6.35, range 16.09–42.99)*	28.50 *(SD 6.19, range 16.09–42.18)*
Father	30.81 *(SD 6.82, range 15.62 – 56.67)*	31.30 *(SD 6.72, range 15.62 – 56.67)*
Social class *(%)*		
Middle class	50.9	54.6
Working class	49.1	45.4
Mother's education *(%)*		
No qualifications	5.1	3.6
Less and 5 GCSEs A*=C/Basic e.g. key skills, NVQ, NNEB	16.6	14.3
5 + GCSEs A*-C or GNVQ higher level	13.9	13.5
A-levels A*-E/BTEC/HNC	11.7	10.8
Undergraduate degree (BA or BSc)/HND	28.0	30.3
Postgraduate degree e.g. MSc, MD, PhD, PG Cert	24.7	27.5
Relationship status at the child's birth *(%)*		
Married	50.3	51.8
Cohabiting	33.7	34.3
In a relationship but not living together	6.3	5.2
Single	9.6	8.8
Ethnicity *(%)*		
British	92.7	93.4
Non-British	7.3	6.6

language was not English or Welsh, or for those with impaired hearing. Ethical approval for all procedures was obtained from the NHS Multi-Centre Research Ethics Committee and the Cardiff University School of Psychology Research Ethics Committee.

The sociodemographic characteristics of the CCDS sample are displayed in Table 1. Analyses comparing the family demographic characteristics of the CCDS sample with the subsample of firstborn children in the large Millennium Cohort Study, the most recent national birth cohort study in the UK, found the sample to be nationally representative (Hay et al., 2021).

2.2. Participants

The middle childhood assessment of the CCDS took place when the firstborn child reached a target age of seven years ($M = 6.96$). Of the original 332 families recruited in pregnancy, 22 families had withdrawn from the study and one family had never been subsequently traced, leaving 309 (93 %) remaining in the study at 7 years. Of those, 287 (93 %) provided data at the middle childhood assessment: 272 were seen in the home and 15 were only able to complete questionnaires as they could not schedule a home visit.

The present analyses focus on the 251 children ($M = 6.95$ years, $SD = 0.38$, 111 girls [44 %] and 140 boys [56 %]) who had completed a free play activity with Playmobil™ figures and played a bespoke video game. Six children refused to complete at least one of the activities; three children did not complete the tasks for procedural reasons; one family withdrew their data; and one session took place in a language other than English or Welsh and no translation was available. In 10 cases, technical problems resulted in data being unavailable for at least one of the tasks.

2.3. Procedure

The middle childhood assessment comprised two 2-hour home visits where the primary caregiver (97 % mothers) completed interviews with one research assistant while the firstborn child completed various cognitive, social, and emotional tasks with a second research assistant; the child's assessment included the free play activity with Playmobil™ figures followed by the bespoke video game. At the end of the assessments, the focal child, their caregiver, and any siblings present took part in interaction tasks. As a thank you for their time, the child was given a £10 book voucher, and the caregiver was given a £20 gift voucher.

2.4. Materials

2.4.1. Free play with Playmobil™ figures

Children were given the opportunity to play with Playmobil™ figures in any way that they would like to for at least three minutes ($M = 2.88$ min, *Range* = .75–3 min). Experimenters were encouraged to only engage with the children's play at the child's request. The Playmobil™ figures depicted adults, children, as well as furniture, toys, and other accessories appropriate for the home and school (see Hashmi et al., 2021; Paine et al., 2019, for more details). The play session was video recorded, with an audio recording as an additional back-up.

2.4.2. The Castell Arth Mawr Adventure Game

The Castell Arth Mawr Adventure Game (CAMGame; Hashmi et al., 2021; Hay et al., 2018) is a first-person perspective game modified from the commercially available game The Elder Scrolls V: Skyrim (Bethesda, 2011). The game was designed in the context of the CCDS, with a focus on children's prosocial and aggressive decision-making (Hay et al., 2018). The game consisted of a narrative of 11 'scenes' portraying the child on a school trip to a castle with a teacher and classmates, identified by the red sweatshirts they wore, and encountering children wearing blue sweatshirts from a rival school. Children were told that in the game they would be on a school trip to a castle and to listen to the characters in the game to find out what to do and where to go. Children began the game outside of the castle with their virtual classmates and teacher; they then progressed through the exterior of the castle to the entrance and travelled through the interior of the castle. The game climaxed with a 'race' to a treasure room inside the castle. The game consisted of challenges and scenarios that might provoke prosocial behaviour, fear-related behaviours, or aggressive responses using a mallet that they had been given at the start of the game. Examples of these scenarios include: a 'storyteller' character asking the child to use their mallet to chop some wood for them; the child choosing to jump or not jump from a high ledge to a lower platform; and the child being verbally teased by the children from the rival school, respectively (see Hashmi et al., 2021, for further details of these specific challenges and a narrative of the game. See https://youtu.be/SpixvsHypg8 for a video demonstration of the CAMGame).

Children's speech and faces were video recorded using the webcam on the laptop that presented the game (with the audio recorded separately as a back-up). Children controlled their avatars using an Xbox™ controller with the right trigger coloured in purple and the left analogue stick coloured white to correspond with instructions given by the game. The researcher explained how to use the controller before the child began playing the game, with reminders given by game characters as a part of the narrative.

2.5. Measures

2.5.1. Children's talkativeness

Children's speech while playing with the Playmobil™ and the CAMGame was transcribed into 5-sec segments. Translators transcribed sessions that took place in Welsh. Segments in which children were not playing the game due to a technical error or were repeating a part of the game that they had already played, or where the player was not participating in either task (e.g., when taking a bathroom break or if the caregiver interrupted the activity for any reason) were excluded from all analyses, including calculations of talkativeness scores and task length. This exclusion was to allow for meaningful comparisons to be made between children. Any instances of non-word noises that were not sound effects were also excluded. A proportional measure of children's talkativeness was computed by dividing the number of 5-sec segments in which the child spoke by the total number of 5-sec segments of the length of the task, resulting in a score between 0 and 1. In previous analyses of the sample, this measurement of talkativeness had been validated using the software programme *Audacity* (Roberts et al., 2013).

2.5.2. Children's verbal engagement during free play with Playmobil™ figures

A coding scheme was adapted from existing measures to assess children's verbal engagement during the free play with toy figures (the coding scheme is displayed in Table 2 with verbatim examples from the present sample; Auwärter, 1986; Giffin, 1984; Howe et al., 1998). ***Enactments*** were defined as speech where children gave a voice to the toy figures, indicated by either an exaggerated tone of voice (Howe et al., 1998), or an increase in the pitch, timbre, or volume of speech (Auwärter, 1986; Doyle & Connolly, 1989), in addition to its content. ***Sound effects*** were coded separately from enactments, as Giffin (1984) has argued that such vocalisations are less within-frame than verbal enactments. ***Narrative*** was defined as speech reflecting the child's own point of view as opposed to the point of view of a character to describe or advance the fictional story (Auwärter, 1986), which included utterances that questioned the experimenter on what might happen next in the narrative, or the current states of characters (Garvey, 1991). ***Management*** speech did not occur in the form of 'play speech' but was produced in the child's natural voice (Doyle & Connolly, 1989) and reflected role assignment, transformations (e.g., pretending an object is something else), rules of play and arrangements of props. Finally, the category ***speech about reality*** was included to capture the extent to which children's speech did not reflect any reference playing with the toys (Auwärter, 1986; Kane & Furth, 1993). When coding children's speech, one segment of speech could be coded as more than one category.

For any cases in which the task ended before three minutes (14.6 %), the coding of children's engagement with the play was pro-rated up to 36 segments (3 min). Two independent observers coded 25 % ($n = 67$) of the transcripts to assess the reliability of the coding scheme. Table 2 presents the results of the reliability analysis (Median Intra-Class Correlation *[ICC]* = .92), indicating excellent coder agreement on the measure.

2.5.3. Children's use of objects during free play

A continuous narrative transcript of children's physical behaviour and use of objects was recorded in 5-s segments that

Table 2
Coding scheme for measuring children's verbal engagement with play.

Category	Sub-category	Definition	Examples	Intra-class Correlation (reliability)
Enactment (E)		The content of the speech reflects the child identifying with the role assumed while engaged in play.	*"'Hey, how about we sit down and play tic-tac-toe?'"*	.99
Sound effects (SE)		The symbolic meaning of an action is reinforced by a sound **that is not necessary if the action occurred in reality**.		.98
Narration (N)	*1. Storytelling.*	Narrative style of talking about the events and characters occurring in the play, but the speech is not in the role of a character inside the fictional reality.	*"She's sailing away, run away from home"*	.99
	2. Commentary.	Speech that is commenting on the fictional scenario **but does not advance the story**.	*"Then she needs a little table"*	.81
Management (M)	*1. Discussion of roles.*	Speech that reflects the assignment of roles to the child or to the experimenter as well as discussion regarding what the role entails.	*"Are you gonna use the grownups?"*	.98
	2. Initiation/ termination of pretence.	Speech that reflects a proposal or intention to pretend; transform a character or object into something novel*; or is an intention to transform a character, area or object into something (this does not include just labelling the characters or scenes but must have an intention, e.g., this is going to be the bedroom). Statements that approve or reject a pretend proposal, transformation or idea.	*"This is the doctor"* *"Let's just pretend it's closed"* *"Can I explode the classroom up?"* *"It's not really an orphanage"*	.88
	3. Rules of play and properties of objects.	Speech that establishes the rules of play in terms of what is allowed, and what is not allowed. Speech that describes the properties of objects (e.g., who they belong to).	*"I'm gonna start the story off, erm off, and then you have to finish it"* *"No, this is their painting"*	.90
	4. Arrangement of props.	Speech that reflects the physical placement of the objects in the scene. This does not include questions about where things **could or should** be placed, but the actual placement of the figures.	*"Hide him in there"* *"Hmm washing machine go over there"*	.91
Speech about reality (R)		Any speech that is not in reference to the Playmobil™ free play activity.	*"(Can I) go on X-Box now?"*	.92

Note. Categories are not mutually exclusive. One segment of speech can contain more than one category. * In the Cardiff Child Development Study, novel transformations were considered as those that were not a part of the battery of social understanding stories that the children were previously told.

corresponded with their speech. Their use of objects was coded using Howe et al.'s (2014) scheme, which categorised the use of toys during play as: *no use of objects*; *set up/organisation* of the toys but not using the toy in a playful manner; *expected use of objects*, defined as children using the toys and animating them in a conventional way, given the form and function of the object; and *creative use of objects*, defined as children changing the identity or function of an object in a way that is not a typical use of that object in reality. An additional category of *handling objects* was included to capture the child simply holding or looking at an object, but not using them in any of the previously mentioned ways. When coding children's object use, one segment of the transcript could contain more than one category.

For any cases in which the task ended before three minutes (14.6 %), the coding of the child's use of objects was pro-rated up to 36 segments (3 min). Two independent observers coded 25 % (n = 67) of the transcripts to assess the reliability of the coding with excellent interrater reliability being established (Median ICC = .97). Data were available for 249 (99 %) of the children (2 children only had audio recordings available).

2.5.4. Children's immersion in the video game

Children's engagement with the fictional world of the CAMGame was measured using a coding scheme that had been developed based on a review of the existing immersion literature and themes that emerged from the children's speech as they played the game. This method resulted in 11 items that categorised children's transcribed speech as reflecting *speech to game characters*; *making references to game characters*; *attributing characteristics to game characters*; *creation of narratives*; *asking questions regarding the use of the controller*; *referring to the rules of the game*; *future thinking in relation to the game world*; *help seeking, expressions of uncertainty and helplessness*;

Table 3
Coding scheme for measuring children's immersion in a video game.

Item	Definition & verbatim examples	Intra-class Correlation (reliability)
Speech to game characters (SGC)	Any speech that is directed towards the characters in the game. Attention may need to be drawn to the characters speech noted on the transcripts to establish if X is responding to a character who has just spoken. *"Where are you going?" "I have a hammer, so get back!" "Look I can jump like you okay!"*	.99
References to game characters (RGC)	Any speech that makes specific reference to the characters in the game **but is not directed to the characters.** *"Where are the blue kids going?" "He said hit the armour." "Why is he the bear king?"*	.99
Characteristics of game characters (CGC)	Any speech made that is in reference to or directed to a game character that is a comment on their personal characteristics. This additionally includes references to the internal states of the characters. This will most likely be an adjective. *"You are naughty" "Wait for me you, rude people" "Those idiots are way behind me" "There's my friend" "He's a bully" "He doesn't know I have a mallet" "She can't see me over here"* Do not include any comments that are about the characters' physical appearance.	.97
Creation of narrative (CN)	Any speech made by the child that is the child bringing their own thoughts, ideas or narrative **that expands beyond what is explicitly present in the game**. The child bringing a novel idea, or something that is not present, into the narrative of the game. *"I'm possible in disguise aren't I?" "The princess has gone." "I'm going to call you Teeny"*	.78
Use of controller (UC)	Any reference to the controller or questions to the experimenter about how to use the controller. *"What do all these do? The X, A, B, Y?" "Which one's the purple one?"*	.98
Rules of game (RG)	Any questions to the experimenter about how to do an action or achieve a goal regardless of whether it is possible given the rules of the game. Or any questions directly asking if the rules of the game allow for an action to occur. *"Can't I just climb over the rocks?" "How do you push them?" "How do you say 'Are you alright?'" "How do I attack?"*	.92
Future thinking (F)	Any statements or questions about what may happen next within the context of the game world. Questions about things happening/characters doing things that are not currently occurring. Any questions to the experimenter about the consequences of the child's actions in the game. *"Is he going to hit me?" "If you go in the water, would you die?" "What happens if you fall off?"*	.90
Help-seeking (HS)	Any questions to the experimenter (or in some cases a game character) about what the child has to do or where to go next in order to progress through the game (goal orientated). This includes asking the experimenter to take over play. This does not include general questions about the game. *"Where's the door?" "So basically you have to find the statue before the blues?" "Can you do the jumps?"*	.95
Uncertainty/Helplessness (UH)	Speech by the child which is an expression of them not knowing how to do something or not being able to do something in the game. *"I don't know which way to go" "I can't do it"*	.93
Emotion (E)	Speech by the child which is an expression of an emotional or affective reaction in relation to the events/characters/narrative of the game. This includes using emotive language to **describe** the game content and language reflecting the child's enjoyment of the game. *"I'm a bit scared" "This is scary" "I'm a bit freaked out" "I really like this game, this is cool"*	.96
Speech about reality (R)	Speech by the child which is unrelated to the game world. Do not include if the child is speaking about other video game. *"What's for dinner?"*	.89

Note. Categories are not mutually exclusive. One segment of speech can contain more than one category. Coding is in reference to the speech relating to the game.

emotion; and *speech about reality*. These items are presented in Table 3 alongside definitions and verbatim examples from the children's speech (Appendix 1 details how the present coding scheme incorporated questions or codes from existing measures of immersion). When coding children's speech one segment of speech could contain more than one category.

Two independent observers coded 25 % ($n = 65$) of the transcripts and established excellent inter-rater reliability for this coding scheme (see Table 3, Median $ICC = .95$). Due to variations in the time taken to complete the game (mean 19:01 min, range 08:30–41:45 min), proportion scores were created to allow meaningful comparisons to be made between the children. For each child, the total frequency of each speech category was divided by the total number of 5-sec segments for the task, resulting in a score ranging between 0 and 1.

2.5.5. Children's use of a virtual mallet in the video game

Children's use of a mallet that they acquired early in the CAMGame was counted from the video screen recordings of children's game play by a trained coder in 5-s segments which corresponded to the transcripts of speech. The use of the mallet was the only physical action, other than movement of the avatar, that children could perform within the game itself. Previous analyses regarding how children used the mallet in responding to the prosocial and aggressive scenarios has indicated consistency with their behaviour outside of playing the game. Specifically, using the mallet in a prosocial way (e.g., helping the storyteller by hitting the wood with the mallet) was associated with prosocial choices in other tasks, and using the mallet in an aggressive way (e.g., choosing to hit the storyteller with the mallet) was associated with teachers' ratings of aggressiveness in the classroom (Hay et al., 2021). Therefore, although the use of the mallet in the game may appear superficially as indicating aggression, mallet use also reflects the behaviour and decision making that the child would engage in. During coding, the 'target' of the mallet use was identified as being a character in the game, a specific object, or the scenery; however, these were combined for the following analyses.

When coding children's use of the mallet, one segment of the transcript could contain multiple instances of mallet use. Inter-rater reliability ($ICC = .998$) was established for the overall use of the mallet by an independent coder who assessed a random subsample of 63 (24.7 %) children. Because the length of time it took each child to complete the game differed (*Mean* = 19:01 min, *Range* = 08:30–41:45 min), a proportional measure of the child's use of the mallet was generated to allow for meaningful comparisons to be made across the children. This was calculated by dividing the total number of times the mallet was used by the total number of 5-sec segments of the length of the task (this score could be larger than 1 because children could use the mallet multiple times in one 5-s segment). Data were available for 247 (98 %) of the children (four children only had audio recordings available).

2.6. Other measures

2.6.1. Family sociodemographic adversity

Sociodemographic information characterising the family environment was collected from mothers' reports at the study onset; maternal variables were used to ensure consistency in the source of information, as not all fathers were participating in the study. At the first wave of the study, an index of family adversity was created using polychoric principal components analysis (PCA). The maternal experiences that contributed to this index were: (a) not having achieved the minimum level of qualifications required for the completion of secondary education in the UK; (b) being 19 years of age or under at the time of the child's birth; (c) not being legally married during pregnancy; (d) being in an occupation classified as lower status according to the Standard Occupational Classification 2000 (SOC2000; Elias et al., 1999) and (e) not being in a stable partnership with the firstborn child's father. These items contributed to a single component that explained approximately 77 % of the shared variance, where positive scores indicate an above average level of adversity at the time of the child's birth. The children in the present sample ($n = 251$) were not significantly different from the original sample ($N = 332$) with respect to their adversity scores, $t(581) = 0.98$, $p = .328$, 95 % Confidence Interval (CI) = (− 0.24 to 0.08).

2.6.2. Children's previous experience with computer games

The duration of time children spent playing computer games was reported by caregivers as an ordinal variable ranging from never to three or more hours a day. However, these data were skewed: 8.9 % of children played video games less than once a week, 42.3 % of children played at least weekly, and 48.8 % played video games at least daily. Therefore, this variable was dichotomised for the present analyses to contrast those children who played computer games daily compared to the other children in the sample (see Hay et al., 2018). Data on this measure were available for 248 (99 %) of children included in these analyses; 48.8 % of children ($n = 121$) were reported to play video games daily.

2.6.3. Verbal ability

Children's vocabulary was assessed using the British Picture Vocabulary Scale (BPVS; Dunn & Dunn, 2009). BPVS data were available for 247 (98 %) children of the sample for this paper. The mean standardised score for children's receptive vocabulary was 99.26 ($SD = 11.78$).

2.6.4. Response inhibition

Response inhibition was measured using the Response Organisation Objects (ROO) task from the Amsterdam Neuropsychological Tasks (ANT; de Sonneville, 1999). The ROO task consists of three parts and children were asked to hold the mouse with the forefinger of each hand on the respective buttons of the mouse. In part 1 (compatible condition), children were presented with a fixation cross on the screen, a red ball appeared on either side of the cross, and children were asked to click the same side of the mouse on which the ball appeared. In part 2 (incompatible condition), a white ball appeared on either side of the fixation cross and children were asked to click the opposite side of the mouse on which the ball appeared. In part 3 (mixed condition), children were presented with both the red and white ball, and were asked to respond by clicking the appropriate sides of the mouse as they were trained to for the previous two parts. The difference in the mean reaction times (ms) between parts 2 and 1 reflect a measure of *response inhibition*, where a lower difference indicates better response inhibition (Paine et al., 2018). Data were available for 241 (96 %) of the children in the present sample. The mean score for children's response inhibition was 303.96 ms (*SD* = 181.85).

2.6.5. Cognitive flexibility

Cognitive flexibility was also measured using the ROO task and was operationalised as the difference in mean reactions times between the compatible trials of the mixed part of the task (part 3) and all trials of the compatible part of the task (part 1). A lower difference in these reaction times indicates better cognitive flexibility. Data were available for 238 (95%) of the children in the present sample. The mean score for children's cognitive flexibility was 691.74 ms (*SD* = 321.09).

2.6.6. Working memory

Children's working memory was measured using the Visuo-Spatial Sequencing (VSS) task from the ANT (de Sonneville, 1999). Children were presented with 9 circles on the screen in a square matrix. Following a beep, a computer-animated hand pointed to a sequence of circles that gradually increased in the number of targets and the complexity of the sequence. Children were asked to replicate this sequence of circles, with the total number of correctly identified targets in the correct order indicating their working memory (Paine et al., 2018). Data on this task were available for 237 (94 %) of children. The mean score for correct targets in the correct order was 66.19 (*SD* = 18.39) out of a possible 100.

2.7. Data analysis

We first describe patterns of children's verbal and nonverbal behaviour, in terms of the variables from the coding scheme, within each context of play. Because the data were not normally distributed, nonparametric analyses (Spearman's Rho, r_s) were used for these initial analyses. Principal Component Analysis (PCA) was then used to identify whether common variance from the coded variables might represent engagement with the fictional worlds of the play frame and video game. We then explored whether resulting factor scores reflecting children's engagement with the fictional worlds were associated with child characteristics. Significant associations ($p < .05$) were carried forward and used as control variables for subsequent parametric analyses exploring whether factor scores reflecting children's engagement with the fictional world of the toy play were associated with their engagement with the virtual world of the video game.

3. Results

3.1. Children's engagement with the fictional world during free play

The descriptive statistics for children's speech and behaviour as they played with the Playmobil™ figures are presented in Table 4. On average, children spoke during this activity for almost two thirds of the time (*M* = .62, *SD* = .26). The most common type of verbal behaviour was constructing narratives or telling stories, with the most common way of using the objects being to set them up.

Table 4 presents the intercorrelations of the items from the coding schemes used to capture children's free play with the Playmobil™ figures. To identify whether children's verbal and nonverbal behaviours during play reflect styles of engaging with the play frame, a PCA was conducted on the items from the coding schemes, with orthogonal rotation (varimax). Because the overall frequency for the use of objects in creative ways was low, it was combined with using objects in expected ways to give an overall *use of objects in expected or creative way* variable. Barlett's test of sphericity, $X^2(36) = 902.49$, $p < .001$, indicated that correlations between items were

Table 4
Means, standard deviations and inter-correlation (r_s) of items from the verbal engagement with play and use of objects coding schemes.

	1	2	3	4	5	6	7	8	9	10	11
1. Playmobil™ talkativeness score	–										
2. Play engagement enactment	.40**	–									
3. Play engagement sound effects	.26**	.43**	–								
4. Play engagement narrative	.57**	.26**	.10	–							
5. Play engagement management	.34**	-.25**	-.20**	.08	–						
6. Play engagement reality speech	.16*	-.02	-.07	-.03	-.04	–					
7. Object use handling	.22**	.19**	.03	.13*	-.02	.11	–				
8. Object use set up	-.30**	-.41**	-.36**	-.19**	.25**	-.17**	.56**	–			
9. Object use expected use	.19**	.63**	.49**	.23**	-.31**	-.13*	.06	-.56**	–		
10. Object use creative use	.22**	.06	.21**	.17**	-.05	.01	-.01	-.07	.04	–	
11. No use of objects	.08	-.15*	-.16**	.02	.10	.32**	.08	-.34**	-.14*	-.05	–
Mean	.62	3.20	0.66	6.20	2.73	1.11	7.65	21.33	3.73	.15	2.86
Standard deviation	.26	5.83	1.94	6.46	2.89	2.23	4.46	7.89	5.42	.81	4.52

Note. * $p < 0.05$, ** $p < 0.01$. Talkativeness scores represent the proportion of segments in which speech occurred during the task.
Play engagement and object use scores represent the mean number of segments in which codeable behaviour or speech occurred.

sufficiently large for PCA. An initial PCA was used to obtain eigenvalues for each component in the data. Three components had eigenvalues over Kaiser's criterion of 1 which in combination explained 62.42 % of the variance, and so were retained in the final analysis. Table 5 shows the factor loadings after rotation, and the percentage of variance explained by each of the factors. Factor scores were generated from the PCA using the regression method and were used for all further analyses.

The items that load on each factor suggests that Factor 1 represents engaging in the role of an *actor*, where children are verbally enacting roles (e.g., *"Then mum said [In play voice]: 'who did it? Tell me the truth'"*); making sound effects (e.g., *"Boing boing boing"* as child is making the 'mum' toy jump on the bed); using the toys in expected ways (e.g., child uses toys to enact one 'child' kicking another 'child') and using the toys in creative ways (e.g., child turns the washing line upside down and raises it in the air whilst saying *"Fly! 4, 3, 2, 1. Blast off!"*). The items that load onto Factor 3 suggest this factor reflects engaging in the role of a *narrator,* in verbally creating stories and narratives (e.g., *"One…goes to steal the sweeties but the teacher…sees him and says no, and then he goes back to the classroom and sits on the naughty chair"*). Finally, Factor 2 represents *not engaging* with the play task as indicated by talking about things outside of the play (e.g., *"Is it snack time? Yeah, we have it at 3 o'clock"*) and not using the objects at all.

3.2. Children's engagement with the fictional world when playing the CAMGame

The descriptive statistics for children's speech and mallet use as they played the CAMGame are presented in Table 6. On average, children spoke during the CAMgame for almost half of the time ($M = .45$, $SD = .19$). The most common form of verbal behaviour was referring to the characters in the game. In terms of mallet use, on average children used the mallet in almost a third ($M = .31$, $SD = .26$) of the 5-sec segments.

Table 6 displays the intercorrelations of the variables from the coding scheme. To identify whether the items from the coding scheme reflect a general tendency to become engaged within the fictional world of the game, a PCA was conducted on the items from the coding scheme and the total observed use of mallet, with orthogonal rotation (varimax). Bartlett's test of sphericity, $X^2(66) = 658.50$, $p < .001$, indicated correlations between the items were sufficiently large for PCA. An initial PCA was used to obtain eigenvalues for each component in the data. Four components had eigenvalues over Kaiser's criterion of 1 which in combination explained 59.10 % of the variance, and so were retained in the final analysis. Table 7 displays the factor loadings after rotation, and the percentage of variance explained by each factor. Factor scores were generated from the PCA using the regression method and were used for all further analyses.

The items that loaded on each factor suggested that Factor 1 represents children's *immersive engagement* within the fictional world of the game, reflected in children's speaking directly to the game characters (e.g., *"You'll never beat me, guys. Gonna get you…Not if I whack you first!"*); referencing them in general (e.g., *"What did she say?"*); and giving them characteristics (e.g., "*I think they know the treasure's down here*"; "*My teacher and my friends*"). In addition, Factor 1 captured the child's creation of additional narratives beyond what was programmed into the game (e.g., *"I'm an Easter bunny! Haha. Boing!"; "What is this, like a secret agency? Yeah!"*); talking about the future of the story within the world of the game (e.g., *"Let's put my weapon back, just in case that bear comes!"; "What happens when I get into the castle?");* and verbally expressing emotions to the content of the game (e.g., *"I'm not scared"; "I find this game so fun"; "If this is actually me and I couldn't see I would just be so scared"*). In contrast, Factor 2 appears to reflect *functional engagement* with the rules and goals of the game (e.g., "*Can I like go to an inventory*?"; *"Are you allowed to walk in the water?"*), including using the controller to navigate through the game (e.g., *"What yellow button?"*) and asking for help (e.g., "*Which way should I go?*"). Factor 3 reflects children primarily *engaging by using the mallet*; and Factor 4 represents *not engaging* with the game, as indicated by talking about things outside of the game (e.g., *"Oh tomorrow, [name] coming over for tea, she's my best friend in school"*).

3.3. The influence of children's characteristics on their engagement with both fictional worlds

Children spoke significantly more often during the free play activity ($M = .62$, $SD = .26$), than while playing the CAMGame ($M = .45$, $SD = .19$), $t(250) = 11.59$, $p < .01$ (95 % $CI = .14–.20$). However, children's propensity to talk was also correlated across both play

Table 5
Summary of principal components analysis results for the engagement with play and use of objects coding schemes.

	Rotated factor loadings		
Item from coding schemes	Engagement as an actor	No engagement with play	Engagement as a narrator
Use of objects in expected or creative way	**.86**	-.09	.07
Play engagement sound effects	**.78**	-.06	.02
Play engagement enactment	**.74**	-.15	.10
Object use set up	**-.56**	**-.51**	**-.56**
Play engagement management	**-.50**	-.12	-.01
No use of objects	-.04	**.87**	-.03
Play engagement reality speech	-.06	**.79**	-.09
Object use handling	.00	.07	**.86**
Play engagement narrative	.02	-.21	**.60**
Eigenvalues	2.64	1.74	1.24
% of variance	29.35	19.35	13.73

Note. Factor loadings over .40 appear in bold.

Table 6
Means, standard deviations and inter-correlation (r_s) of items from the immersion coding scheme and use of the mallet.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. CAMGame talkativeness score	–												
2. Speech to game characters	.69**	–											
3. References to game characters	.67**	.52**	–										
4. Characteristics of game characters	.60**	.65**	.64**	–									
5. Creation of narratives	.55**	.54**	.42**	.52**	–								
6. Use of the controller	.40**	.19**	.25**	.16**	.21**	–							
7. Rules of the game	.38*	.23**	.29**	.18**	.20**	.23**	–						
8. Future thinking	.40**	.28**	.52**	.39**	.33**	.20**	.23**	–					
9. Help seeking	.43**	.18**	.38**	.23**	.18**	.22**	.36**	.27**	–				
10. Uncertainty/helplessness	.27**	.03	.16**	.08	.10	.15*	.02	.15*	.21**	–			
11. Emotion	.51**	.40**	.41**	.37**	.32**	.25**	.13*	.21**	.23**	.27**	–		
12. Speech about reality	.13*	.03	.06	.01	.08	.15*	.13*	.12	.03	.08	.05	–	
13. Total use of the mallet	.18**	.41**	.22**	.31**	.33**	.11	.15*	.16*	.02	-.17**	.13*	-.01	–
Mean	.45	.02	.06	.02	.01	.01	.02	.01	.03	.01	.01	.00	.31
Standard deviation	.19	.03	.04	.02	.01	.01	.01	.01	.02	.01	.01	.00	.26

Note. * $p < 0.05$, ** $p < 0.01$. All scores are as a proportion of task length.

Table 7
Summary of principal components analysis results for the immersion in the video game and mallet use coding scheme.

	Rotated factor loadings			
Item from coding schemes	Immersive engagement	Functional engagement	Mallet engagement	No engagement
References to game characters	**.82**	.19	-.03	-.01
Characteristics of game characters	**.82**	.01	.16	-.05
Future thinking	**.71**	.08	-.07	.05
Creation of narratives	**.60**	.22	.32	-.08
Speech to game characters	**.60**	.17	.41	.07
Emotion	**.52**	.14	-.19	.20
Help seeking	.14	**.71**	-.24	-.25
Rules of the game	.09	**.69**	.19	.12
Use of the controller	.17	**.61**	.00	.12
Uncertainty/helplessness	.15	.28	**-.70**	.19
Total use of the mallet	.27	.24	**.69**	.09
Speech about reality	.03	.06	-.02	**.94**
Eigenvalues	3.56	1.47	1.05	1.02
% of variance	29.64	12.22	8.77	8.47

Note. Factor loadings over .40 appear in bold.

activities, $r(251) = .46$, p .01. Because of this association, a mean score reflecting children's average propensity to talk in both contexts was computed and used in all further analysis.

We first explored whether the factor scores reflecting children's engagement in both fictional worlds were associated with relevant child characteristics, in order to establish which characteristics should be carried forward as covariates in subsequent analyses. The children's characteristics included: mean age across sessions; the mean talkativeness score across both contexts; child sex; exposure to family adversity; and scores on the verbal ability, response inhibition, cognitive flexibility, and working memory tasks. When examining the scores for engagement with the fictional world of the video game, the additional variable of experience with video games was included.

3.3.1. Play with toys

Children's *not engaging* with the toy play was not significantly associated with any child characteristics (see Table 8). Children's engagement with the play frame as an *actor* was significantly associated with child sex, with boys engaging as an actor more often than girls did, $t(325.02) = -3.79$, $p < .01$ (95 % $CI = -.68$ to $-.22$). Children's engagement as a *narrator* was positively correlated with children's mean propensity to talk across both play activities, $r(249) = .31$, $p < .01$.

3.3.2. Video game play

Not engaging with the video game was not associated with any child characteristics (see Table 8). *Immersive engagement* with the fictional world of the video game was correlated with children's mean propensity to talk across both play activities, $r(247) = .52$, $p < .01$. Boys showed higher factor scores for immersive engagement than girls did, $t(253) = -2.71$, $p < .01$ (95 % $CI = -.58$ to $-.09$). The factor score reflecting children *engaging with the functional aspect* of the game was positively associated with children's talkativeness, $r(247) = .38$, $p < .01$.

Children's tendency to engage with the video game by *using the mallet* was positively associated with their age, $r(247) = .16$, $p < .05$

Table 8
Means, standard deviations and inter-correlation (*r*) of factor scores reflecting engagement when playing with the Playmobil™, immersion in the video game, and variables reflecting child characteristics.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Engagement as an actor in the free play	–															
2. Engagement as a narrator in the free play	.00	–														
3. No engagement in the free play	.00	.00	–													
4. Immersive engagement in the video game	.14*	.08	.05	–												
5. Functional engagement in the video game	-.01	-.03	.05	.00	–											
6. Engaging with the mallet in the video game	.18**	.06	.03	.00	.00	–										
7. No engagement with the video game	-.03	-.01	.04	.00	.00	.00	–									
8. Child age (months)	.01	-.05	.05	.08	-.05	.16*	.04	–								
9. Child sex	.22**	.02	-.01	.17**	.07	.44**	-.05	.00	–							
10. Socioeconomic adversity	.08	-.03	.08	.09	.01	.15*	.06	.24**	.11	–						
11. Verbal ability	-.09	-.05	-.06	-.06	.11	-.18**	.05	-.23**	-.08	-.48**	–					
12. Response inhibition	.05	-.01	-.06	.02	.04	-.07	.05	-.13*	-.13*	-.06	-.02	–				
13. Cognitive flexibility	-.03	-.02	-.06	.08	.08	-.09	.07	-.10	-.09	.01	.01	.54**	–			
14. Working memory	-.10	-.04	-.05	-.09	-.00	-.04	.00	.20**	-.15*	-.26**	.32**	-.19**	-.18**	–		
15. Previous experience with video games	.08	.07	-.05	.11	.02	.12	-.02	.04	.14*	.10	-.09	-.14*	.03	-.14*	–	
16. Mean talkativeness	.11	.31**	.06	.52**	.37**	.04	.10	-.08	.07	.03	.06	.04	.13*	-.10	.09	–
Mean	0	0	0	0	0	0	0	83.45	1.57	.00	98.90	309.42	692.19	65.72	1.49	.54
Standard deviation	1	1	1	1	1	1	1	4.52	.50	.99	12.08	692.19	316.81	18.48	.50	.20

Note. * $p < 0.05$, ** $p < 0.01$.

and the family adversity score, $r(247) = .15, p < .06$, but use of the mallet was negatively associated with verbal ability, $r(250) = -.18$, $p < .01$. Boys showed higher factor scores than girls did for this style of engagement, $t(253) = -7.79, p < .01$ (95 % $CI = -1.11$ to $-.66$).

3.4. Associations between children's engagement with the fictional worlds of toy play and video game play

Engaging as an *actor* in the free play activity was positively correlated with *immersive engagement* in the fictional world of the video game, $r(245) = .14, p < .05$, and particularly with engagement with the game by *using the mallet*, $r(245) = .18, p < .01$ (see Table 8).

To establish the relative contribution of the associated child-related factors of sex (girls coded as 1, boys as 2) and talkativeness, these variables were entered into a linear regression model (see Table 9a). In the final model, only sex ($\beta = .11, p < .05$) and children's talkativeness ($\beta = .52, p < .01$) significantly predicted the children's *immersive engagement* with the video game, $F(3, 241) = 35.12, p < .01$. Children's engagement as an actor in the toy play did not account for significantly more variance than the child factors alone, and so it did not represent a significant step in the model, $F(1, 241) = .90$, $p = .34$, $\Delta R^2 = .003$.

To establish the relative contribution of the associated child-related factors of age, sex (girls = 1, boys = 2), exposure to socio-economic adversity, talkativeness, and verbal ability on the association between children's engagement as an *actor* in toy play and tendency to engage with the game by *using the mallet*, these variables were entered into a linear regression (see Table 9b). In the final model, only sex ($\beta = -.40, p < .01$) significantly predicted children's tendency to engage with the game by *using the mallet*, $F(5, 235) = 12.88, p < .01$. Children's engagement as an actor during toy play did not account for significantly more variance than the child factors alone, and so did not represent a significant step in the model, $F(1, 235) = 1.11$, $p = .34$, $\Delta R^2 = .004$.

4. Discussion

4.1. Summary of the findings

We investigated children's engagement in fictional worlds in two contexts, when they played with toy figures and when they played a bespoke narrative-driven video game. We found that children's forms of engagement and disengagement with the fictional world during free play with toy figures were similar to those identified in previous studies of toy play: acting out roles, narrating stories, or not playing at all (Auwärter, 1986; Giffin, 1984; Howe et al., 1998; Scarlett & Wolf, 1979). The analyses yielded a factor (labelled *actor*) that distinguished the children's roles as actors versus managers of their toy play. This demonstrates that engagement in toy play takes different forms for different children.

We also explored children's experience of engaging with the fictional world in a first-person video game containing a narrative and multiple dynamic characters. The first factor that emerged from the PCA represented *immersive engagement* with the fictional world of

Table 9
Prediction of children's engagement in the CAMGame from their engagement as an actor in the free play, controlling for covariates.

Predictor	ΔR^2	*B*	*SE B*	β	95 % CI
Regression Model A: Prediction of children's immersive engagement in the CAMGame from their engagement as an actor in the free play, controlling for covariates					
Step 1	.30**				
Constant		-1.82	.22		-2.26 to −1.39
Child's sex		.25	.11	.12*	.04 to .46
Mean talkativeness		2.70	.28	.53	2.15 to 3.24
Step 2	.00				
Constant		-1.77	.23		-2.22 to −1.32
Children's engagement as an actor in the free play		.05	.06	.05	-.06 to .16
Child's sex		.23	.11	.11*	.01 to .45
Mean talkativeness		2.67	.28	.52**	2.12 to 3.22
Regression Model B: Prediction of children's tendency to engage with the game by using the mallet in the CAMGame from their engagement as an actor in the free play, controlling for covariates					
Step 1	.21**				
Constant		-.34	.59		-1.49 to .82
Child's sex		.83	.12	.42**	.60 to 1.06
Mean talkativeness		.07	.30	.01	-.52 to .65
Socioeconomic adversity		.06	.07	.06	-.08 to .19
Verbal ability		-.01	.01	-.12	-.02 to .00
Step 2	.29				
Constant		-.32	.59		-1.48 to .83
Child's sex		.81	.12	.40**	.57 to 1.04
Mean talkativeness		.03	.30	.01	-.56 to .62
Socioeconomic adversity		.06	.07	.05	-.08 to .19
Verbal ability		-.01	.01	-.12	-.02 to .00
Children's engagement as an actor in the free play		.06	.06	.06	-.05 to .18

Note. *$p < .05$, **$p < .01$. The coefficients presented are those obtained in the final model: $F(3, 241) = 35.12, p < .01, R^2 = .30$.
Note. *$p < .05$, **$p < .01$. The coefficients presented are those obtained in the final model: $F(5, 235) = 12.88, p < .01, R^2 = .20$.

the game as measured by the children's interaction with the game characters and events within the narrative. A second factor, interpreted as children's *functional engagement* with the video game, reflected children's questioning how to use the controls and asking about the rules and goals of the game environment. Other factors that emerged in the analyses were the extent to which children used the mallet or did not engage with the game. Thus, some children were more engaged in the fictional world of the game than others, in a manner analogous to engagement in the fictional world created in toy play.

Finally, we explored associations between children's engagement with the fictional worlds of toy figures and a video game. The children's engagement with the play frame as an actor in toy play was positively associated with their *immersive engagement* with the fictional world of the video game, especially with their tendency to use a virtual mallet. This finding suggests that there is an underlying link between children's enacting a role within the *play frame* (see Fig. 4.1; Auwärter, 1986; Garvey, 1991; Giffin, 1984; Kane & Furth, 1993) and their immersion within the virtual world of a video game (Brown & Cairns, 2004; Calleja, 2011; Ermi & Mäyrä, 2007), though these associations were explained by child characteristics. These findings support arguments that, in middle childhood, children's behaviour while playing video games is related to their other forms of play (Lillard, 2014; Singer & Singer, 2005, 2013), and this relationship is explained by child-level factors.

In this sample, those children who engaged with the play frame when playing with toys also engaged in the virtual world of a first-person video game. Our study has further extended the existing literature that claimed that engaging in fictional worlds results in emotional *reactions* in various contexts (Bateson, 1955; Harris, 2000; Taylor, 1999); our findings have demonstrated that children's *active engagement* in fictional worlds show similarities across two superficially different contexts, toy play and video games.

There were, however, differences between the two play environments. We found that children spoke for a greater proportion of time when playing with toys than when playing the video game. This finding is in line with existing research showing that children speak more when playing with dolls than when playing on tablet games, both when playing on their own and with a partner (Hashmi et al., Gerson, 2022). It may be that the more open-ended format of the free play activity gave children more opportunity to talk as compared to the more pre-scripted and restricted nature of the video game. Similarly, Howe et al. (2020) found that children tended to have more conversation when playing with an open-ended village toy set than when playing with a more restrictive train set. Nonetheless, in our sample, despite the difference between the two types of play, the proportion of time children spoke when playing with toys and when playing the video game were positively correlated. This finding indicates that despite some differences in the amount of children's speech in different types of play, some children are more talkative than others across play contexts.

4.2. The influence of child characteristics on toy play and video game play

When investigating the child characteristics influencing children's engagement with the play frame in the toy play, only children's sex appeared to have an influence; boys were more likely than girls to be engaged as an actor in the Playmobil task. These findings stand in contrast with Wolf et al.'s (1984) results of gender differences in styles of playing in a smaller sample of younger children. Similarly, children's sex was significantly associated with children's engagement with the fictional world of the video game, with boys having higher immersive engagement scores than girls.

These findings might be interpreted in terms of boys' and girls' levels of familiarity with toy figures and video games. Crucially, children's previous experience with playing video games was not associated with their engagement with the fictional world of the video game. This suggests that the sex difference was not driven by boys having more experience with playing games. Our finding is consistent with the findings of Martinovic et al., (2016) who found gender differences in children's immersion for some of the games used in their study, but stands in contrast to the adult literature of immersion where no significant gender differences were reported (Brockmyer et al., 2009; Byun & Loh, 2015; Kothgassner et al., 2018; von der Pütten et al., 2012).

4.3. Characteristics of the tasks and the sample

Although immersive engagement with the virtual world of a video game is a subjective experience, it is also influenced by the technical and physical aspects of the game (Brown & Cairns, 2004; Calleja, 2011; Ermi & Mäyrä, 2007). Certain features of the CAMGame resemble factors that have been associated with immersion in past studies, including the first-person point of view in the game (Denisova & Cairns, 2015) and the engaging narrative (Calleja et al., 2016; Wu & Rank, 2015). These features of a first-person narrative game contrast with other types of video games played by children, such as puzzle games (e.g., Tetris), strategy games (e.g., SimCity, Chess) and more casual mobile games (e.g., Angry Birds) which are analogous to those used in previous research (e.g., Martinovic et al., 2016). It is possible that, in line with the gender differences found by Martinovic et al. (2016) being related to the cognitive skills required for the games, the features of the narrative in the CAMGame were more engaging for the boys in our sample than the girls, which resulted in their greater experience of immersing in the fictional world of the video game. Therefore, future research is needed to study children's engagement with the virtual worlds in different types of video games that contain different features, in order to explore the consistency in children's immersion across games, as well as the gender or individual differences that may derive from the different features present in different games.

Finally, associations between children's engagement in the fictional worlds of the toy play and video game play were explained by children's talkativeness as well as their sex. Several interpretations of the associations with children's sex in our study are possible. As with research on toy preferences, it may be that the gender-stereotyped messages regarding children's play that become entrenched in children through socialisation and branding can explain these differences (Reich et al., 2018). Children use the content of media as a source material for their play, which are likely to portray gender-stereotyped styles of playing (Desmond, 2001; Galda, 1984; Singer & Singer, 1990). Indeed, in one study, boys who watched more 'superhero' television programmes displayed more 'male-stereotyped' play, in the form of increased aggression and violence (Coyne et al., 2014), whereas, in another study, girls who watched more media that included Disney princesses engaged more in 'female-stereotyped' behaviour, which included playing dress up and playing house (Coyne et al., 2016). Additionally, differences in parental play styles according to children's sex or gender could possibly explain the presence of these differences. For example, research has found that parent-daughter dyads, irrespective of parent gender, display more joint pretend play than parent-son dyads (Lindsey & Mize, 2001). Therefore, further research is needed to understand the nature of gender and sex differences in children's play with toys and video games, particularly in terms of why boys appear to be more engaged in these fictional worlds than girls.

4.4. Limitations

The present study has limitations. Firstly, some children spent a disproportionately long time using the objects to set up the play or organise the toys, compared to other uses of the toys. Although the inclusion of children's non-verbal behaviour provides richer detail regarding their engagement with play and captures engagement from those children who are less talkative, the nonverbal variable loaded negatively onto all factors that emerged from the PCA. This poses a statistical issue, insofar as the factors resulting from a PCA with an orthogonal rotation should not be correlated. However, when the PCA was conducted omitting this item, it resulted in identical factor loadings for the other items. Therefore, the measure of nonverbal behaviour was retained to represent the range of children's actual behaviour in this setting. Future work is needed to explore possible associations between nonverbal behaviour and engagement in toy play.

The time spent in setting up toys could be regarded as an accurate reflection of this form of engagement being present in all children's play. However, for some children, this was all that they did. This focus on setting up the objects could be partly due to the short length of the task. It could well be the case that children used the objects in this way to *initially* set up the play and, if given more time, they would move onto other ways of engaging with the play activity.

An extended free play activity lasting longer than three minutes would potentially capture more varied ways of children engaging with the toys beyond setting them up. However, it should be acknowledged that the use of a brief play activity in the protocol allowed for a large sample of children to be assessed in the home, with many potential covariates of play included in the analyses. Furthermore, not all children spent so much time setting up the toys, and some were engaged primarily in enacting roles and telling stories for most of the time. Prior research with longer play sessions (10–15 min) has similarly found that some children spend most of their time setting up their play (Howe et al., 2014). Given that the factor scores reflecting children's engagement with the fictional worlds of the free play and the much longer video game were correlated, it seems likely that the brief assessment of play with toys provided an accurate reflection of different children's different styles of play.

Furthermore, an additional limitation of the present work was the reliance on verbal measurement of children's engagement with the fictional worlds of play, particularly for the video game. It is possible that children were engaged with the fictional worlds of toy play and video game but were doing so using private inner speech. If this occurred, the findings of the present study would represent a conservative approach to measuring children's engagement with fictional worlds. Although inner speech cannot be directly measured, we did find associations between children's propensity to speak across both conditions. In particular, we found correlations between the factor scores representing children's engagement in the virtual world of the video game, which comprised verbal categories, and children's engagement in the fictional world of their play with toy figures, which comprised both verbal and physical behavioural categories. The consistency across the two types of play provides some validity for our approach.

Order effects may have influenced the patterns of results. For reasons to do with the assessment protocol as a whole, all assessments were presented in a fixed order within both testing sessions. It is possible that the stories and questions from the task battery may have prompted patterns of engagement that influenced how the children played with the toys, which then primed their subsequent engagement with the virtual world in the video game. However, the order of tasks was implemented to ensure data collection was efficient and children's interest was maintained, and so it permitted the data collection of relevant measures that were used as covariates included in the present study. The decision to end the session with an enjoyable computer game provided a positive experience for the children. These decisions were made in the context of home observations as part of longitudinal research. Future methodological studies could explore the possibility of order effects in experimental settings.

Finally, the differences in the content presented and the time spent playing with the toy figures and the video game limit our ability to make direct comparisons between the two play activities. Our aim was to investigate whether there was a conceptual association between children's engagement with fictional worlds when playing with toys and when playing a video game, using bespoke measures for each play activity. This initial approach to the comparison of engagement in the fictional world of the toy play and virtual world of video games should be expanded upon in future research that aligns protocols for toy play and video game tasks, so that it is possible to make direct comparisons.

4.5. Conclusions

In summary, we have demonstrated that children engaged with fictional worlds in similar ways when playing with toy figures and a first-person, narrative driven video game. Although some sex differences were noted throughout the study, other potential sources of individual variation did not appear to play a role, and so these styles of engagement with the two fictional worlds reflect the preferences of individual children. These findings have important implications, particularly for practitioners who may use play, both with toys and video games, in education (Cheng et al., 2015; Hamari et al., 2016; Lillard, 2013) and therapy (Singer & Singer, 1990). Children's engagement in fictional worlds confers learning through the ability to rehearse facts and to allow for flexible thinking

(Lillard, 2013). Therefore, some children may benefit more from play-based approaches for therapy and education due to individual differences in their engagement with the fictional world of the play. In conclusion, our findings underscore the importance of children's engagement in the imagined and fictional worlds of play, which in middle childhood is expressed in a similar way in different contexts.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and ethical agreements.

Conflict of Interest Statement

The authors of this manuscript have no conflicts of interest to declare.

Data Availability

Data will be made available on request.

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Appendix 1. The coding scheme measuring children's immersion alongside the analogous items from existing measures of immersion

Item	Analogous item from existing coding scheme
Speech to game characters	"Verbal answer in dialogue with virtual content" (von der Pütten et al., 2012). "At any point did you become so involved that you wanted to speak to the game directly" (Jennet et al., 2008).
References to game characters	"Commenting the virtual content" (von der Pütten et al., 2012).
Characteristics of game characters	"Commenting the virtual content" (von der Pütten et al., 2012). "Belittled game characters (showing frustration)" (Martinovic et al., 2016).
Creation of narrative	"Parts of the story are formed by me in the course of playing the game", "I can control the progress of the game story" (Qin et al., 2009).
Use of controller	"I can control the character to move according to my arrangement", "I can control the game interface" (Qin et al., 2009).
Rules of game	"Having trouble understanding the game" (Martinovic et al., 2016).
Future thinking	"Were you able to anticipate what would happen next in response to actions that you performed?" (Witmer & Singer, 1998).
Help seeking	"Having trouble understanding the game (Asking questions during play)" (Martinovic et al., 2016). "I know my next goal while finishing an event every time" (Jennet et al., 2008).
Uncertainty/Helplessness	"Having trouble understanding the game, asked rater for instructions/to clarify; did not seem to understand" (Martinovic et al., 2016). "Were there any times during the game in which you just wanted to give up?" (Jennet et al., 2008).
Emotion	"Showing enjoyment", "Showing frustration", "Seeming anxious/nervous" (Martinovic et al., 2016). "My emotion often varies with the stories progress", "I like the type of game", "I often feel nervous or excited because of the game", "When I am playing the game, I feel as if I have experienced the context of the game in person, just like I am who the avatar is in the game", "I used to be so integrated into the avatar in the game that I could feel his/her feelings" (Qin et al., 2009). "I feel different", "I feel scared", "I get wound up", "Playing makes me feel calm" (Brockmyer et al., 2009). "To what extent did you feel emotionally attached to the game?" (Jennet et al., 2008).
Speech about reality	"Getting distracted while playing" (Martinovic et al., 2016) "To what extent did you feel consciously aware of being in the real world whilst playing?" (Jennet et al., 2008)

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