The Influence of Videogame Frequency, Violence Recognition and Age on Information Integration.

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Master thesis

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Abstract

This paper examines the role of videogaming frequency and violence recognition and its consequent effect on information integration for adults and children. The study utilised previously collected data from 314 participants (184 children, 130 adults) from Radboud University. Participants wrote essays on cow milk after reading four texts, which were then scored for their ability to integrate information. Multiple regression analyses addressed three key research questions: the influence of single-player and multiplayer gaming frequency, the impact of gaming on different mediums (console/PC vs. phone/tablet), and the effect of violent/non-violent game recognition on information integration. Results indicated that neither single-player nor multiplayer gaming frequency, nor the medium of gaming, significantly predicted information integration. Similarly, the recognition of violent or non-violent games did not influence information integration. Across all analyses, age emerged as the only significant predictor, indicating that older participants integrated information better regardless of their gaming habits.

These findings differ from previous research suggesting that single-player games and console/PC gaming are more beneficial for cognitive skills and that violent games negatively impact learning outcomes. This study underscores the need for further research to explore the nuanced relationship between gaming habits and cognitive development.

Theoretical Framework

Introduction

‘Once a new technology rolls over you, if you're not part of the steamroller, you’re part of the road.’ – Stewart Brand. In today's digital landscape, the internet serves as an expansive gateway to a vast knowledge repository, challenging individuals to cultivate nuanced skills for discerning multifaceted and contradictory information from various sources of reliability (Salmerón et al., 2018). This digital evolution prompts a shift in information engagement. Moreover, the impact of technology extends beyond information consumption, revolutionizing interpersonal interactions through smartphones and digital media (Parry & le Roux, 2021).

This increased exposure to digital media raises questions about potential cognitive effects. Videogames are one of the digital media platforms on which these potential cognitive effects have been investigated. The videogame industry has experienced exponential growth in recent years (Clement, 2024), becoming a dominant force in the digital media landscape. However, this rise has sparked debates over potential negative side effects, particularly the impact of violent videogames on behaviour. Early research suggested that such games could increase aggressive behaviour among players (Porter & Starčević, 2007), but these findings are debatable. Some studies propose that violent behaviour might stem from pre-existing traits rather than gameplay itself, challenging the notion of a direct causal link between violent games and aggression (Squire, 2003; Dowsett & Jackson, 2019). Conversely, other research highlights the potential cognitive benefits of videogames, suggesting improvements in reaction times, visual attention, and short-term memory skills (Castel et al., 2005 and Blacker & Curby, 2013). Furthermore, the educational potential of videogames has gained attention, with studies indicating that games can enhance learning by fostering skills like problem-solving and critical thinking (Squire, 2003; Shaffer, 2005; Noorozi et al., 2020 & Bing, 2013).

This paper aims to explore the multifaceted impacts of videogames, addressing gaps in the current literature by examining the differential effects of singleplayer versus multiplayer games, the influence of gaming platforms, and the varying impacts on children and adults (Bowman et al., 2015; Harteveld and Bekebrede, 2010; Peters et al., 2021 & Borgonovi, 2016). Through this comprehensive analysis, the researcher provides a balanced understanding of videogames' potential influences on cognitive and educational outcomes.

Videogames and their potential negative side effects

Over the years, the videogame industry has become one of the biggest industries in the current digital media landscape. The most popular gaming companies nowadays are worth several billions of dollars. For example, the market capitalisation of Nintendo in 2024 was close to 60 billion dollars, whereas for Electronic Arts this was almost 35 billion dollars (Clement, 2024). In a similar fashion, both Nintendo and Electronic Arts are very prominent names in the current videogame creation landscape.

Nonetheless, this booming of the current videogame industry did not come without any previous downsides. Namely, in the recent past it was thought that violent videogames could potentially cause negative side effects towards the players, such as an increase in violent behaviour (Porter & Starčević, 2007). They also suggest that there is a potential link to violent videogames and aggressive behaviour. Thus, it is argued that aggressive behaviour could potentially be a consequent reaction towards playing more violent videogames. However, it also discussed in the article that aggressive behaviour may be an expression of hostile traits that existed before the exposure to violent videogames, or even a possible combination of the aforementioned factors. This could indicate that relation between violent videogames and violent behaviour is only causal and there is no actual correlation between the two factors.

Additionally, various studies have also argued against the claim that videogames increase violent behaviour (Squire, 2003; Dowsett & Jackson, 2019). Squire (2003) was ahead of his time and indicated very early on already that general videogame research found no association between videogame usage and social maladjustment, such as an increase in violent behaviour. He argued that the concern with videogames is by and large unfounded and consequently, there is very little reason for concern about their effects on the players. The opposite was even indicated. It is argued that videogames could potentially aid towards an increase in cognitive abilities. Squire (2003) stated the following: “Educators should pay attention to these emerging developments in videogaming, as they hold promise for generating many new theories of engaging learners in interactive digital environments”

Following up on this, Dowsett and Jackson (2019) found that previous studies may have misplaced their results on aggression levels by not incorporating competitiveness within their study. For example, their experiment looked specifically at competitiveness and violence in videogames and their corresponding effects on behaviour. As a result, it was found that both competitiveness and violence in videogames did not impact aggressive behaviour. This would suggest that the previous claim concerning a possible increase in violent behaviour caused by videogames is untrue, even in highly competitive and violent games, and that perhaps it is time to shift towards the positive contributions video games could have in terms of the current digital media environment and its conducive response towards cognitive abilities.

Positive influence of videogames

There have been various studies that found a positive influence of videogames on various related cognitive skills and abilities (Castel et al., 2005 and Blacker & Curby, 2013). Videogame players have a faster reaction time to detect targets, and in both easily and more difficult visual search tasks compared to people who do not play videogames (Castel et al., 2005). This perceived distinction between the videogame players and non-videogame players could be attributed to the fact the videogame players have developed faster stimulus-response mappings that cater specifically to various types of visual attention tasks. These differences in reaction and response times indicate that videogames could have a profound effect on visual system and motor responses.

Additionally, Blacker and Curby (2013) investigated visual short-term memory within action videogames players and non-action videogames players. Visual short term memory skills are correlated with learning new skills, solving novel tasks and acquiring new knowledge. It was found that action videogame players still display a visual short-term memory advantage over non-action videogame players, even when the video-game players were given limited time to process the experimental items into their memory. Possibly suggesting that videogame players bolster an advantage over non-videogame players in term of visual short-term memory skills. This effect might be explained by the notion that action videogames often provide players with a dynamic and intricately evolving visual setting where success or failure is frequently based on the player's ability to maintain efficient visual attention and accurate visual memory.

Nonetheless, these potential positive effects on cognitive skills and abilities might be influenced by the medium that the type of game is played on. The videogames utilised in the previous studies (Castel et al., 2005 and Blacker & Curby, 2013) were played on traditional mediums, such as on a videogame console (e.g., Xbox & PlayStation) or PC/laptop. However, statistics have shown that mobile games make up a larger percentage of the total worldwide videogame market revenue compared to both PC and console games combined (Clement, 2023). This would indicate that ample amount of modern gaming actually occurs on the mobile smartphone instead of these traditional forms of gaming media. This opens up the question on how mobile videogames compare to more traditional videogame media (e.g. console/computer) in terms of their potential positive influence. A study by Bowman et al. (2015) examined various factors surrounding mobile phone gaming with regards to user search and download behaviour of the participants. One of their main findings was that none of the traditional gratifications that were associated with videogame playing (overcoming challenges, competition and social relatedness) were found in their data concerning mobile phone gaming. This could suggest that mobile phone gaming is viewed differently than more traditional console or computer gaming. A potential implication of this could be that mobile phone gaming has less potential towards stimulating a positive effect on cognitive skills and abilities in comparison to more traditional videogaming on a console or PC.

Nevertheless, these are the perceived effects of videogames on very specific cognitive skills and abilities, but what about the potential effect of videogames on information comprehension and integration.

Videogames and Education

Several studies have found early on that videogames could be potentially powerful educational and cultural learning tools that could increase learning potential (Squire 2003, & Shaffer, 2005). Squire (2003) argued that, as designers of interactive learning environments, instructional technologists can largely benefit from current development in videogames. Interactive fiction and online games can inform the design of learning environments. Online games could offer instructional technologists' chances to understand how online environments are designed to support community development. A good example of utilisation of these factors is Duolingo. Duolingo is a highly popular language-learning platform that offers courses in multiple languages and does this by utilising videogame elements (Shortt et al., 2021). The app contains elements such as challenging tasks, reward incentives, systematic levels and the ranking of users according to their achievements.

Additionally, Shaffer (2005) proposes the importance of videogames in education, because they present players with simulated worlds. Worlds that, if well-constructed, go beyond presenting mere isolated skills, but incorporate particular social practices. A good example of a game that utilises these benefits is Minecraft. Minecraft has been found to not only increase creativity, but also increase problem solving, critical thinking and communication skills (Sajben et al., 2020). Thus, it is argued that videogames could possibly aid players to participate in valued communities of practice and so also positively develop the ways of thinking that organize those particular practices.

Following up on the studies by Squire (2003) and Shaffer (2005) on gamification, several studies (Noorozi et al., 2020 & Bing, 2013) have further investigated the impact of videogames in educational settings in the context of improving information integration by increasing argumentation and writing skills. Noorozi et al. (2020) presents a systematic review on the impacts of game-based learning on argumentation skills. One of the general outcomes was that a commonly reported positive learning outcome of game-based learning was a high level of argumentation skills and engagement with the learning outcome. The most commonly reported factors influencing the learning outcomes of game-based learning in the review were feedback, challenge and collaboration. This could indicate that utilising elements that are commonly used in videogames, such as e.g., receiving feedback, overcoming challenges and collaboration could lead to an increase in values such as argumentation skills and engagement in an educational setting. Therefore, this highlights the importance of elements contained within videogames that could potentially lead to an increase in argumentation skills. However, outside of this educational context, this could also indicate that videogames as a medium in itself could potentially have positive influences on the argumentation skills of their players.

Moreover, Bing (2013) investigated the potential effect of action-adventure videogames on enhancing participants' narrative writing skills. 'Action-adventure' is a hybrid genre that combines specific elements from both action and adventure type games respectively. More specifically, they investigated the link between commercial videogames and the teaching and learning of the English language, with a specific focus on narrative writing. Despite the implicit presentation of the game's narrative structure, players internalize its elements, as evidenced by similarities in their post-experience narrative essays. As a result, this might suggest that action-adventure videogames may contribute to improving second language English learners' narrative writing skills through knowledge transfer. Nevertheless, these are the perceived effects of videogames on information comprehension and integration.

Singleplayer vs. multiplayer

Thus far, various positive influences have been found that videogames could have on cognitive skills and abilities, as well as on information integration in various educational settings. However, one factor that has not been thoroughly investigated is how people actually play their videogames. For example, Bing (2013) specifically delves into the genre of action-adventure videogames. Moreover, more previously, Castel et al (2005) and Blacker & Curby (2013) also studied action-videogames specifically. Both these genres of videogames are most commonly played in a singleplayer mode, leaving a gap for the potential influences of multiplayer games. Harteveld and Bekebrede (2010) investigated in their study potential differences between learning in singleplayer games versus multiplayer games. They found that singleplayer games are usually characterized by being very data intensive and utilizing very individual learning processes. Based on this it could be said that singleplayer games are best utilized whilst trying to convey a standard/specific set of knowledge and skills. On the contrary, multiplayer games are characterized as being more intensive with regards to the actual process and utilising open-ended and more social learning strategies. From this could be concluded that multiplayer games might be better suited when the learning objectives are more socially oriented. A potential implication from this could be that singleplayer games are better at conveying a specific set of knowledge and skills, such as information integration, than their multiplayer counter parts.

Videogames and children

Most of the video game data taken from previous studies discussed in this paper have been drawn from adult participants. However, children actually make up a very big percentage of the gaming community as well, and they should therefore not be overlooked with their relative importance on the topic. A study by Peters et al. (2021) found that playing action videogames significantly improved reading accuracy, rate and consequent comprehension in children (aged 8 to 13) with dyslexia. In their study they analysed a game called ‘Fruit ninja’. The study analysed the effect of playing 5 hours of action videogame training utilising ‘fruit ninja’ on reading, rapid naming, eye movements and visuo-temporal processing. Playing fruit ninja for 5 hours significantly improved reading accuracy, rate, comprehension and rapid naming amongst all participating children. Contrarily though, increasing training demands did not enhance the efficacy of the results. It was even shown that the group of children that were trained less extensively displayed higher rates of cognitive skills than the more extensively trained children. This would indicate that perhaps there is a threshold where playing more videogames is not helpful anymore towards enhancing cognitive abilities, at least in the context of children.

Additionally, Borgonovi (2016) investigated video gaming and gender differences in digital and printed reading performance among 15-year-old students. One of the things they found was that students who play singleplayer games moderately have a higher performance in both paper-based and computer-based reading tests. Contrarily, they also found that students playing collaborative online games in the same frequency is generally associated with a steep reduction in achievement levels. Indicating a clear distinction between the functionality of singleplayer and multiplayer gaming in terms of academic achievement, in as was found previously by Harteveld and Bekebrede (2010). Moreover, a too high frequency of play for both singleplayer and multiplayer gaming was found to hinder academic achievement overall. This further adds to the point that there might be a cap in terms of gaming frequency, where playing more hours only grants negative results instead of positive, at least for children. Further research should be elicited that investigates the impact of this videogame frequency threshold for adults and children respectively.

Research Gap

Despite the extensive investigation into the effects of videogames on cognitive skills, educational outcomes, and behaviour, several critical areas remain underexplored.

Firstly, although there is significant literature on the potential negative effects of violent videogames (Porter & Starčević, 2007), the possible positive contributions (Squire, 2003; Dowsett & Jackson, 2019), such as enhanced problem-solving skills, strategic thinking, and stress relief, are less understood. Investigating these potential benefits, especially in the context of violent games, could provide a balanced perspective on their overall impact.

Furthermore, while previous studies have focused on the cognitive and educational impacts of singleplayer action-adventure games (Castel et al., 2005; Blacker & Curby, 2013; Bing, 2013), the distinct effects of multiplayer games, particularly in fostering social learning and collaborative skills, remain inadequately explored. Moreover, overall, it was found that singleplayer games yield better results in terms of educational outcomes (Harteveld and Bekebrede, 2010). Future research should systematically compare singleplayer and multiplayer games to determine how they differently influence cognitive skills and educational outcomes such as information integration.

Additionally, the shift from traditional gaming platforms (consoles and PCs) to mobile gaming has not been sufficiently examined in terms of cognitive and educational benefits. Given that mobile gaming often lacks the traditional gratifications associated with console/PC gaming (Bowman et al., 2015)**,** further studies should investigate how the medium of play influences cognitive skills and learning outcomes.

Lastly, most research has predominantly focused on either adult or adolescent gamers, often neglecting the comparative analysis between these age groups. Studies have shown that children might respond differently to video frequency than adults (Peters et al., 2021; Borgonovi (2016). There is a need for detailed studies that examine how age moderates the cognitive and educational impacts of videogame play, considering both the developmental and neurological differences between children and adults.

Therefore, the research questions for this study are as followed.

RQ1: To what extent does the frequency of playing singleplayer and multiplayer videogames in combination with age predict information integration?

H1: Playing singleplayer games more often will better predict information integration than multiplayer games for both adults and children.

RQ2: To what extent does the frequency of playing videogames on different mediums (console/computer vs mobile phone) in combination with age predict information integration?

H2: Playing more often on a console/computer will better predict information integration than playing on phone/tablet for both adults and children.

RQ3: To what extent does violent/non-violent videogame recognition in combination with age predict information integration?

H3: Being able to recognise more non-violent videogames will better predict information integration than being able to recognise more violent games for both children and adults.

Method

Participants/Subjects

The current study will utilise previously collected data from two data sets that were originally collected at Radboud University. The total number of participants for the study was 318 (184 children and 134 adults) However, four adult participants were removed during the preliminary statistical analyses process for having filled in incomplete answers to several demographics' questions, creating a usable number of 314 total participants. Age was a crucial factor; therefore, participants were split into two groups based on age. The children group consisted of 184 children from both 'Groep 6' and 'Groep 8' as indicated in the Dutch primary school system with a mean age of 10 (M = 10.93, SD = 1.10, Range = 4.98). The adult group consisted of 130 adults with a mean age of 22 (M = 22.10, SD = 7.00).

Additionally, the current study also measured gender, educational level and mother tongue. The children group in terms of gender indicated that 52.7% felt like a boy, 44.6% felt like a girl, 1.1% felt like both a girl and a boy, 1.1% preferred not to say and .5% felt like a neither a boy AND a girl. For the adult group in terms of gender 79.2% felt like a woman, 19.2% felt like a man and 1.5% felt like neither a woman or a man. For educational level of the children group, the highest educational levels of their respective parents were used as a measurement. This was found to be 42.9% HBO, 25% university level, 20.7% MBO, 3.8% HAVO, 3.8% VMBO and 3.8% indicated something different. For the adult group in terms of highest achieved educational level indicated 53.8% Secondary education, 31.5% Bachelor level, 8.5% Master level and 6.2% HBO minors or pre-masters. For the children group in terms of spoken language spoken at home 90.2% indicated Dutch, 0.5% indicated Dutch Egyptian, 0.5% indicated Dutch English, 0.5% indicated Dutch Portuguese, 0.5% indicated Dutch Tigrigna, 0.5% indicated Persian, 3.2% indicated Polish and 3.1% indicated something else. For the adults 96.2% indicated Dutch as their home language and 3.8% indicated Dutch and a secondary language spoken at home.

Materials/ Instruments

Essay and scoring:

For both participant groups, information integration was measured through an essay. The participants were asked to write an essay to advice the principal of a school on whether cow milk should be given to children. All of the participants read four texts about the topic of cow milk and they were then asked to write the essay to the principal of the school whilst still being able to access the four texts.

The content of these four texts was selected to represent four different topics that could outline potential arguments made for or against the usage of cow milk. These four topics were health (Milk is healthy vs Milk is unhealthy), economics (Milk contributes to the economy vs. Land for cows can be used differently), environment (Farmers do their best for the environment vs. Cow farts play a major role in global warming) and Ethical/animal welfare (Cows like to be milked vs. Dairy cows have a bad life). The participant groups both received four texts. Two of those texts contained arguments pro-milk, whereas the other two texts contained arguments that were anti-milk.

The scoring of the essays for both groups was based on literature by Braasch et al. (2022) and Braten et al. (2022). This process was identical for both groups. In this approach, the essays were coded by extracting idea units (or arguments) from the provided essay texts. These idea units were counted based on the number of arguments actually used in the participants' text. Each participant then received a score from either 0 to 8 based on the number of arguments used from the preliminary cow milk texts. For each participant, this computed into a score ranging from 0 to 8 that determined their perceived level of information integration. A score of 8 indicated a high level of information integration, whereas a score of 0 indicated a low level of information integration.

The adult group was already coded by the previous researcher, only the children group needed to be coded for this research. Before the coding of the children, the two researchers of this study test-coded 30% of the participants to analyse the reliability of the coding. The reliability between the first and the second coder was excellent $\alpha = .97$. The cases of disagreement were discussed and the rest of the sample was coded.

Videogame Frequency

For both groups, frequency of playing videogames was operationalised through asking the participants how often they play singleplayer games on console/pc, singleplayer games on phone/tablet, multiplayer games on console/pc and lastly multiplayer games on phone/tablet, with 5 semantic differential options to choose from. The answers options included 'never or almost never', 'some weeks yes, other weeks not', 'once every week', 'once every day' and 'multiple times per day'. These were then combined to create four frequency categories. These categories were singleplayer frequency, multiplayer frequency, console/pc frequency and phone/tablet frequency. These four categories were used for the further analyses. Additionally, for the children this part of the data was split into two separate categories, namely gaming frequency during the week and gaming during the weekend. For the adult group this was referred to as just 'week', with no distinction between workweek or weekend. The reason for this was based on a pilot study that suggested that the weekday frequency was highly correlated with the weekend frequency. Therefore, for the current study these two separate categories for the children group were combined into one variable as to accord with the measurements of the adult group.

In terms of scoring, a measurement from 1 to 5 was created that measures for each participant how they scaled in terms of their frequency of playing videogames, for all four aforementioned categories (singleplayer, multiplayer, console/pc and phone/tablet). A 1 indicated the lowest frequency (never or almost never), whereas a 5 indicated the highest playing frequency (multiple times per day).

Age

Age was operationalised by splitting the participants in two groups. The first group contained the children and the second group the adults. All participants in the children group were asked whether they were either in 'Groep 6' or 'Groep 8' in correlation with the Dutch primary school grouping system. The second group contained participants that were all measured to be over the age of 18.

Violent/non-violent

The type of videogame participants played was operationalised through 10 pictures that were displayed to both groups. These ten pictures each displayed an example of a popular type of video game from various different genres. Five of these games were classified as being violent and five as non-violent based on their PEGI-score. PEGI is a company that provides age ratings in more than 38 European countries to ensure that game content is appropriate for different age groups (*PEGI*, n.d.). The video games included were: FIFA (Non-violent), Roblox (Non-violent), Minecraft (Non-violent), Leage of Legends (Violent), CS: GO (Violent), Grand Theft Auto 5 (Violent), Call of Duty (Violent), Among Us (Non-Violent), Gardenscapes (Non-violent) and Apex Legends (Violent). The participants were asked to identify the videogames by selecting the name out of a list of other names (16 videogames in total). Then the score was coded 1 if they were able to match the correct game with the corresponding picture and 0 if matched incorrectly. This created a number of violent and non-violent games that the participants actively recognised.

In terms of computing the scores, the current study instigated the creation of one measurement score for each participant. This score was the recognised violent videogames subtracted from the non-violent videogames, creating a violent/non-violent scaling score. This score ranged from -5 to 5 depending on how much violent/non-violent games each participant recognised correctly. A score of 5 indicated a high level of non-violent videogame recognition, whereas a score of -5 indicated a very high level of violent videogame recognition for the participants. For example, a participant with 4 non-violent games and 1 violent game recognised will get a combined score of 3. These scores were then used to answer the respective research question.

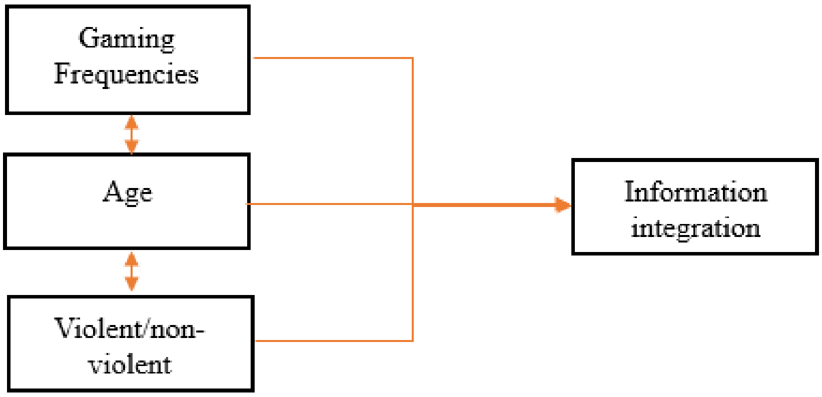
Demographic characteristics

The demographic characteristics were operationalised as followed. Gender was measured by asking the participants what their gender is. For the children the options included ‘Boy’, ‘Girl’, ‘I prefer not to say’, ‘I feel like a boy and a girl’ and ‘I don’t feel like a boy or a girl’. For the adults the options included ‘Male’, ‘Female’, ‘I don’t feel like a man or a woman’. In terms of languages spoken at home, the participants were asked what language they speak at home. The options were ‘Dutch’, ‘Dutch and another language, namely….’ And ‘Not Dutch, but ….’.

Design

In the analysis of the current study, age (children vs. adults) was regarded as a between-subjects variable, since age was measured with the children and adult groups separately. For gaming frequency and violence recognition, the combined data from both groups was added together to create a combined set of statistics for ‘singleplayer frequency’, ‘multiplayer frequency’, ‘console/PC frequency’ and ‘phone/tablet frequency’ and ‘violent/non-violent’ as described in the Materials/Instruments section. Additionally, figure 1 was added below to display the relationship between the proposed variables.

Figure 1.



Procedure

The questionnaires for the adult participants were taken in person in a lab at Radboud University. Each person had an individual session within a sound attenuated booth. Before this session, the participants were asked for their consent towards usage of the data. In this individual session the participants firstly went through the entire questionnaire regarding various background characteristics. After the initial questionnaire came the part in which the participants were asked to fill in various checklists regarding digital media usage. This section was referred to as ‘DME’ and consisted of three parts. Namely, ‘Part is about which digital devices you have at home’, ‘Part 2 is about your use of these devices’ and ‘Part 3 is about what you do on these devices during the week’. At the end of the questionnaire and DME section, after carefully reading the preparatory texts, the participants were tasked to write their personal essay with regards to the aforementioned topics regarding drinking cowmilk. Afterwards, each adult participant was thanked for their participation and awarded 10 euros as a monetary incentive.

For the children group, the questionnaires were taken in a group session within a classroom setting. Before the session, the parents of the children were asked to give consent towards letting their child partake in the study. The process was similar to the adult group. The participants firstly went through the entire questionnaire, then the DME section and afterwards were tasked to write their essays. The children group were rewarded with a small gift for their participation.

Statistical treatment

Reliability analyses with Cronbach's alpha were used to investigate the reliability of variables that contained more than one item. Firstly, several frequency analyses were conducted to investigate the preliminary videogaming demographics of the participants. For the main analysis, three multiple regression analyses were conducted to investigate the effect of videogame frequency (singleplayer vs. multiplayer and console/pc vs. phone/tablet), violence recognition (-5 – 5) and age (children vs. adult) as predictors of information integration in an essay (0-8).

To answer the first research question regarding whether singleplayer gaming frequency, multiplayer gaming frequency and age could significantly predict the consequent information integration of the participants, a regression was done including singleplayer frequency, multiplayer frequency and age group as predictor variables, with information integration as the variable to be predicted. To answer the second research question regarding whether console/PC gaming frequency, phone/tablet gaming frequency and age could significantly predict the consequent information integration of the participants, a regression was done with console/pc frequency, phone/tablet frequency and age group as predictor variables, with information integration as the variable to be predicted. To answer the third research question regarding whether violent/non-violent videogame recognition and age can significantly predict the consequent information integration of the participants, a regression was done with violent/non-violent videogame recognition and age group as predictor variables, with information integration as the variable to be predicted.

Three separate regression analyses were chosen specifically to investigate the potential mitigating influences of the age groups on each of the researchable factors individually, alternatively to combining all of the factors into one regression without the potential interactions.

Results

Descriptives

Multiple frequency analyses were conducted to investigate the preliminary videogaming demographics of the participants. Separate analyses were done for both the adult and children participants group. In terms of essay scores, it was found that the adults (Mode = 3.00, Range = 7,00) scored higher in terms of essay integration compared to the children (Mode = 1.00, Range = 7,00). None of the children nor the adults were able to integrate all 8 essay arguments that were utilised in the texts.

In terms of overall single-player gaming frequency the adults (M = .65, SD = .80, Range = 3.00) scored lower than the children (M = 2.47, SD = .1.04, Range = 4.00). In terms of overall multiplayer gaming frequency the adults (M = .31, SD = .55, Range = 2.00) scored lower than the children (M = 2.00, SD = 1.11, Range = 4.00). In terms of overall frequency with which the participants played on a console or laptop/computer, the adults (M = .35, SD = .68, Range = 4.00) scored lower than the children (M = 2.04, SD = 1.29, Range = 4.00). In terms of overall frequency with which the participants played on a phone or tablet, the adults (M = .59, SD = .83, Range = 4.00) scored lower than the children (M = 2.35, SD = 1.14, Range = 4.00).

In terms of the participants ability to recognise non-violent videogames (Mode = 4.00, Range = 4.00), 34.6% of the adults were able to recognise four, 20.0% three, 18.5% all five, 15.4% two and 11.5% of the adults were able to recognise only one. For the children (Mode = 4.00, Range = 4.00) 66.3% was able to recognise four non-violent videogames, 24,5% five, 7.1% three, 1.6% two and 5% was able to recognise only one. In terms of the adult participants' ability to recognise violent videogames (Mode = 2.00, Range = 5.00) 33.8% were able to recognise two violent videogames, 23.8% one, 22.3% three, 11.5% four and 2.3% were able to recognise all five violent videogames. For the children (Mode = 1.00, Range = 4.00) 37.5% was able to recognise only one violent videogame, 31% two, 14.7% was unable to recognise even one violent videogame, 13% three, 3.8% four and none were able to recognise five violent videogames.

To what extent does the frequency of playing singleplayer and multiplayer videogames in combination with age predict information integration?

The multiple regression analysis to answer the first research question shows that the three variables entered, singleplayer gaming frequency, multiplayer gaming frequency and age group explained 19% of the variance in essay scorings of the participants (F (3, 310) = 24.44, $p < .001$). Table 1 indicates that age group was shown to be a significant predictor of essay scoring ($\beta = .38$, $p < .001$). This shows that the participants' information integration increases with .38 SD for each increase of 1 SD in terms of the age group, given that all other variables are kept constant. However, singleplayer gaming frequency ($\beta = -.03$, $p = .773$) and, multiplayer gaming frequency $\beta = -.06$, $p = .504$) were not significant predictors of the information integration of the participants. Additionally, the interactions between singleplayer frequency and age ($\beta = .07$, $p = .737$) & multiplayer frequency and age ($\beta = -.29$, $p = .321$) were also insignificant.

Table 1.

Regression analysis for singleplayer gaming frequency, multiplayer gaming frequency and age group as predictors of information integration. (N = 313)

Predictor Variable	*B*	*SE B*	β
Intercept	.64	.45	
singleplayer gaming frequency	-.03	.11	-.03
multiplayer gaming frequency	.07	.36	-.06
age group	1.19	.23	.38***
singleplayer x age group	.08	.23	.07
multiplayer x age group	-.29	.29	-.24
R^2	.19		
R	.44		
F	24.44		

Note. *** = $p < .001$

To what extent does the frequency of playing videogames on different mediums (console/computer vs phone/tablet) in combination with age predict information integration?

The multiple regression analysis to answer the second research question shows that the three variables entered, console/PC gaming frequency, phone/tablet gaming frequency and age group explained 20% of the variance in essay scorings of the participants (F (3, 310) = 25.33, $p < .001$). Table 2 indicates that respondent age was shown to be a significant predictor of essay scoring (β = .36, $p < .001$). This shows that the participants' information integration increases with .36 SD for each increase of 1 SD in terms of the age group, given that all other variables are kept constant. However, console/PC gaming frequency (β = -.02, $p = .757$) and, phone/tablet gaming frequency (β = -.13, $p = .068$) were not significant predictors of the information integration of the participants. Additionally, the interactions between console/PC frequency and age (β = -.17, $p = .373$) & phone/tablet frequency and age (β = .07, $p = .706$) were also insignificant.

Table 2.

Regression analysis for console/PC gaming frequency, phone/tablet gaming frequency and age group as predictors of information integration. (N = 313)

Predictor Variable	*B*	*SE B*	β
Intercept	.76	.44	
console/PC gaming frequency	-.02	.08	-.02
phone/tablet gaming frequency	-.15	.08	-.13
age group	1.15	.23	.36***
console/PC x age group	-.18	.20	-.17
phone/tablet x age group	.07	.18	.07
R^2	.20		
R	.44		
F	25.33		

Note. *** = $p < .001$

To what extent does violent/non-violent videogame recognition in combination with age predict information integration?

A multiple regression analysis to answer the third research question shows that the two variables entered, violent/non-violent videogame recognition and age group, explained 19% of the variance in essay scorings of the participants ($F (2, 311) = 36.26$, $p < .001$). Table 3 shows that respondent age was found to be a significant predictor of essay scoring ($\beta = .45$, $p < .001$). This shows that the participants' information integration increases with .45 SD for each increase of 1 SD in terms of the age group, given that all other variables are kept constant. However violent/non-violent videogame recognition ($\beta = .04$, $p = .520$) was not a significant predictor of the information integration of the participants. Additionally, the interaction between violent/non-violent videogame recognition and age group ($\beta = -.007$, $p = .967$) was also insignificant.

Table 3.

Regression analysis for violent/non-violent videogame recognition and age group as predictors of information integration (N = 313)

Predictor Variable	*B*	*SE B*	β
Intercept	.07	.36	
violent/non-violent recognition	.04	.07	.04
age group	1.43	.19	.45***
violent/non-violent recognition x age group	-.005	.13	-.007
R^2	.19		
R	.44		
F	36.26		

Note. *** = $p < .001$

Conclusion/Discussion

The purpose of this study was to examine the influence of videogame frequency, medium and violence recognition on information integration for adults and children. The first research question regarded whether frequency of playing singleplayer and multiplayer videogames in combination with age predicted information integration. The second question regarded whether to what extent the frequency of playing videogames on different mediums (console/computer vs mobile phone) in combination with age could predict information integration. The third research question regarded to what extent violent/non-violent videogame recognition in combination with age could predict information integration.

Consequently, the first hypothesis stated that playing singleplayer games more often will better predict information integration than multiplayer games for both adults and children. The second hypothesis stated that playing games on console/PC would better predict information integration for adults. The third hypothesis stated that being able to predict more non-violent games was a better predictor for information integration than being able to recognise more violent games for both adults and children

The results show that none of the predicted variables (singleplayer, multiplayer, console/PC, phone/tablet and violence recognition were able to influence information integration. Moreover, age did not play a mediating role in this effect. However, the results did show that age separately influences information integration of the participants for each of the analyses.

The influence of age on information integration

Before going in depth with the discussion of the different research questions, the effect of age will be discussed. The results indicate that the age groups separately were able to influence the consequent information integration of the participants for all of the research questions. The findings revealed that the adult participants scored higher than the younger participants in terms of their respective information integrating levels, regardless of the gaming related factors used in the study. On average, the adults were able to integrate three out of the eight arguments into their essays, whereas the children were able to integrate only one. Showcasing a considerable difference between the adults and children. Nonetheless, this result can be explained quite simply. Namely, adults have had a significantly longer time to develop the skills necessary to successfully integrate information and properly formulate it into words due to their respective age difference and accumulation of education over the years. Therefore, it would make sense that writing and comprehension skills of adults are, generally speaking without interference of other factors, more advanced than those of children, especially those that are as young as 8 to 10 years old.

The influence of singleplayer vs. multiplayer videogaming in combination with age on information integration

The results for the first research question show that neither singleplayer gaming frequency nor multiplayer gaming frequency predict the respective information integration for the participants. This is different from previous literature (Harteveld and Bekebrede, 2010 & Borgonovi, 2016). Harteveld and Bekebrede (2010) found that that there is a high likelihood that multiplayer games are potentially worse at conveying a specific set of information and skills, such as information integration, than their singleplayer gaming counterparts. Therefore, this would suggest that their respective educational learning potential is also different. Furthermore, Borgonovi (2016) indicated that students playing collaborative online games in the same frequency as playing singleplayer games were associated with a steep reduction in their corresponding achievement levels.

However, the current study found no difference between singleplayer gaming frequency and multiplayer frequency in terms of their respective influence on the information integrating performances of the participants. This could potentially indicate that multiplayer games are not actually inferior at their ability to convey a specific set of knowledge and skills or cause a reduction in educational achievement in comparison to singleplayer videogames. One of the reasons for this distinction might be due to the specific outcome variable used in this study, namely information integration. The previous study by Harteveld and Bekebrede (2010) predicted multiplayer and singleplayer gaming outcomes in the context of 'a specific set of information and skills.' In their initial phrasing they indicate a potentially very broad spectrum of 'skills' that could be influenced by either playing a singleplayer or multiplayer game. However, the results from this study show that information integration is most likely not one of the specific 'skills' that is influenced by the potential effects of playing a singleplayer game compared to a multiplayer game. Nonetheless, this does not necessarily mean that other measurable skills will also not be influenced by this videogaming distinction. This would open up the question as to whether singleplayer and multiplayer gaming frequency potentially do have an influence on other skills, outside the scope of information integration.

Additionally, it could also be that singleplayer and multiplayer games have changed significantly from the date of the previous literature (2010 and 2016). Gaming in and of itself is a medium that changes very rapidly. Especially in recent years it has progressed exponentially compared to even as close to as five or ten years prior. Most modern games that are released nowadays contain both singleplayer and multiplayer elements, allowing the player to choose which they prefer and also switch at any given point in the game. Therefore, the lines between singleplayer and multiplayer elements in modern videogames might be more blurred for modern videogames, compared to older videogames that were either explicitly singleplayer or multiplayer. This could possibly explain the found difference between previous literature.

Furthermore, the results show that the different age groups were not found to be mediating the potential effect of singleplayer and multiplayer gaming on the information integration of the participants. Suggesting that there is no evidence that this previously found difference between singleplayer and multiplayer videogames is influenced by the age of the participants. This could show that the potential influences that singleplayer and multiplayer gaming frequency could have, is relatively similar to both younger and older videogame playing audiences.

Therefore, regardless of the age of the respondents, an implication from this study could be that singleplayer and multiplayer games potentially have similar capabilities in terms of being educational learning tools, then was believed by previous literature (Harteveld and Bekebrede, 2010 & Borgonovi, 2016).

The influence of console/PC vs phone/tablet videogaming in combination with age on information integration

The results for the second research question show that neither console/PC gaming frequency nor phone/tablet gaming frequency altered the consequent information integration of the participants. This is inconsistent with previous literature (Bowman et al., 2015). One of the key findings by Bowman et al. (2015) was that mobile phone gaming was found to not be connected with the traditional positive benefits of videogaming (e.g., overcoming challenges and competition) in comparison to gaming on console/PC. Meaning that mobile phone gaming should be worse at conveying potential positive benefits to their respective audiences, than their console/PC counterparts.

However, this might not the case. Namely, the current study found no difference between console/PC gaming frequency and phone/tablet gaming frequency in terms of their respective influence on the information integrating performances of the participants. Potentially suggesting that playing videogames on a mobile phone is not different at conveying potential positive/negative cognitive benefits than playing on a console or PC. The reason for this could be that mobile games have evolved tremendously from the date of the previous literature (e.g., 2015), showcasing that perhaps they are now equally similar to videogames on a console or PC. The development of mobile phones has increased exponentially in recent years and as a result it would make sense that their respective capabilities have increased as well. Additionally, many games that were previously only playable on a console or PC can nowadays be played on mobile phones as well. Popular examples of videogames with those types of capabilities are Call of Duty and Minecraft, each having their own complete mobile version fully akin to the respective console/PC game. A potential consequence of this could be that gaming on mobile devices has grown very similar to console/PC gaming, which could explain the results from this study.

Additionally, the results show that the different age groups were not mediating the effect of the different gaming media on information integration. This validates the notion that this perceived increase in similarity between console/PC games and mobile games holds true for both adults and children alike.

An implication from this could be that mobile phone gaming is not worse at being an educational learning tool for their respective audiences in comparison to more traditional gaming media (e.g., a console or PC). Gaming in this day and age on a mobile phone and on a console/PC might be more similar in terms of the effects they could have on their users than was previously thought. Additionally, this could also imply that the type of device used for gaming might be less important than was believed previously, potentially influencing future research directions and opening up discussions about the benefits of gaming across different platforms.

The influence of violence recognition in videogames in combination with age on information integration

The results for the third research question show that violent/non-violent videogame recognition could not predict the consequent information integration of the participants. In addition, the different age groups do not play an influencing role in this effect. These results show that videogames and violence in videogames do not by definition cause negative effects on their users in terms of being able to integrate information. This is in line with previous studies by Squire (2003) and Dowsett & Jackson (2019). Squire (2003) argued that the concern with violence in videogames is mostly unfounded and that there is very little concern about the potential effects of violence in videogames causing negative side-effects on their players. Additionally, Dowsett & Jackson (2019) further concluded that the potential negative effects that supposedly come with videogames are untrue, even in highly competitive and violent games. The results from this study underline this notion by showing that videogames and violence in videogames are not necessarily correlated with a decrease in the users' ability to integrate information. A potential reason for this could be that any potential negative impact of violent videogames is likely to occur only very selectively. What this means is that it these potential detriments only affect a small subset of individuals who might already have predispositions for aggression or antisocial behaviour. Therefore, generally speaking most people would not be influenced by this, which could explain the results from this study.

Additionally, the results show that the different age groups were not mediating the effect of violence recognition on information integration. Illustrating that videogames and more specifically violence in videogames does not negatively impact the players, regardless of their age. Even though one could argue that children are generally speaking cognitively less developed compared to adults and could therefore be more susceptible to factors akin to violence in videogames. However, the results from this study demonstrate otherwise.

An implication from the current study could be that the prevalent concerns regarding the negative cognitive impacts of violent videogames may be overstated. More specifically, the findings suggest that playing violent or non-violent videogames does not impair participants' ability to integrate information, regardless of their age. This implies that the fear that violent videogames inherently cause cognitive detriments is not supported by this research.

Limitations

Before delving into the limitations, a major strength of the study at hand should be discussed. Namely, the usage of a combination of self-reports (videogaming frequencies) and more objective measurements (violence recognition checklist) to measure the various factors concerning videogame playing. Using both self-reports and objective measurements in research has several advantages, offering a more comprehensive understanding of the subject. One of these advantages is that using this combination caters towards a more holistic understanding of the total data. For example, self-reports provide insights into more subjective experiences and perceptions, whereas objective measurements offer data that is more quantifiable and less prone to certain biases and errors. Therefore, by leveraging the strengths of both self-reports and objective measurements, a more balanced and in-depth analysis was achieved in the process of conducting this study.

Nonetheless, a potential limitation to this study could be attributed to the selection of the materials. More specifically, referring to the selection of the violent/non-violent videogames. Namely, were the games presented as violent and non-violent through the aforementioned PEGI scaling actually representative of incorporating violence, or respectively not incorporating violence. PEGI is a company that creates age ratings for all types of videogames. These ratings incorporate several indicators to justify whether a game adheres to or falls within a certain age range. Examples of these indicators include but are not limited to: ‘bad language’, ‘gambling’, ‘sex’ and ‘violence’ (*PEGI*, n.d.). Consequently, a low PEGI rating might indicate that a game is legally playable for younger audiences, but this does not guarantee that it is for that reason also fully without violence. For example, it could also mean that there is very minimal violence existing within that game compensated by other factors. However, on the other side a game with a relatively high PEGI age rating might contain several aforementioned indicators (e.g., bad language, gambling and sex) excluding violence. Showcasing that their high PEGI rating is based off of other factors than just violence alone. Therefore, even though the selection of the violent/non-violent games was done very thoroughly, there is a possibility that certain videogames might not have been fully representative for either completely violent or completely non-violent based solely on their given PEGI scores.

Nevertheless, future research should further investigate the influence of videogaming frequency and violence recognition on information integration for adults and children, as the results from this study do not fully align with previous research.

Conclusion

To conclude, this study aimed to explore the impact of videogame///// frequency, medium, and violence on information integration among adults and children. The findings indicated that neither the frequency of singleplayer nor multiplayer gaming significantly predicted information integration, contradicting previous research suggesting that singleplayer games are more conducive to learning due to their data-intensive nature. Similarly, the medium of gaming (console/PC vs. mobile) did not affect information integration, challenging earlier studies that considered console/PC gaming as more beneficial for cognitive skills. Additionally, recognising violent or non-violent games did not influence information integration, aligning with past research that downplays the negative cognitive effects of violent games. Across all research questions, only age emerged as a significant factor in information integration, independent of gaming habits.

Overall, this study has found that playing videogames (singleplayer, multiplayer, on console/PC and phone/tablet), either violent or non-violent, does not seem to negatively impact learning capabilities regardless of the age of the player.

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