International Journal of End-User Computing and Development
Volume 8 • Issue 2 • July-December 2019

How Game Designers Can Account for Those With Autism Spectrum Disorder (ASD) When Designing Game Experiences

Robert Costello, Newcastle College University Centre, UK
https://orcid.org/0000-0002-8962-7533

Jodie Donovan, Newcastle College University Centre, UK

ABSTRACT

Autism Spectrum Disorder (ASD) is a prevalent neurodevelopmental disability among gamers where individuals belonging to this group of conditions have difficulty understanding non-verbal cues. Though game accessibility is a focal point in the games industry, there has been a keen focus placed on developing accessibility. Consequently, this study examines the perspective of video games from individuals who have autism to gain further insight into the needs of these individuals. The preliminary study is to discover if autistic users' difficulty reading non-verbal cues extends to their perception of a game environment and if these individuals can experience sensory distress while playing video games. A prototype was created to further understand the non-verbal cues to help shape the foundation of accessibility framework. The preliminary results concluded that autistic users frequently misread or fail to pick up on the non-verbal cues used by developers to drive game flow and narrative (e.g., sign-posting), in addition to experiencing sensory distress while playing video games.

KEYWORDS

Accessibility, ASD, Dame Design, Game Cues, Level-Design, Non-Verbal Cues, Principles, Sensory Distress, Theory

DOI: 10.4018/IJEUCD.20190701.oa1

INTRODUCTION

Autism Spectrum Disorder (ASD) is an umbrella term for a range of cognitive impairments that affect a person's ability to communicate with others, interact socially, and influence their interests and behavioral patterns (Autism org uk, 2016). Those with Autism perceive the world differently to neurotypical people in a way that can be overwhelming and cause considerable emotional distress. For some individuals with Autism, everyday stimuli such crowded public places (Falkmer, et al., 2015), lighting (Grandin, 2009), sounds (Boddaert et al., 2003), and even touch (Kaiser et al., 2015) can be extremely unpleasant and, in some cases, painful (Marco et al., 2011). Individuals who have high-functioning Autism may appear outward and intelligent, often initiating communication and social interaction (Holland, 2018). These persons can typically take care of themselves and carry out rudimentary tasks without assistance, whereas others may need daily care. Strickland, (1997) stated, "As adults, about two-thirds of persons with Autism remain severely disabled and unable to provide even basic personal care".

ASD affects one in 59 minors in the United States alone, which accounts for between one and two percent of the country's population (Centers for Disease Control and Prevention, 2018). Similarly, one percent of the United Kingdom's population is also affected (Baron-Cohen, et al., 2009). Brown et al. (2011), expand on the research carried out by Baron-Cohen et al., (N.D) and indicate in the UK that, "Around 25 people in every thousand have mild or moderate intellectual disabilities and about four or five per thousand have severe intellectual disabilities". Brown et al. (2011), or as The Guardian Newspaper indicates, "One in every 100 people in the UK has ASD, with more boys diagnosed with the condition than girls" (Guardian Newspaper, 2018, P1). Literature does indicate that individuals with disabilities often have other forms of impairments from; sensory, excellent motor control to mobility impairments that restrict their everyday abilities. The authors indicates that through changes to more adaptable widespread screening approaches to Autism prevalence in the US (Wright, 2017) and other countries would likely be higher similar to that of the UK. Subsequently, more parents would be inclined to have their child(ren) tested for ASD if they did not incur significant medical bills (Buescher, Cidav, & Knapp, 2014; Shimabukuro et al., N.D.). As such, it is essential to consider that many people out there are playing video games utterly unaware of their developmental disorder (The Independent, 2018). These users have needs that differ from neurotypical persons, and yet there is minimal framework suggesting creative solutions to meet the needs of these consumers (Yeun et al., 2010; Torrente et al., 2012).

Accessibility in games is an area that is continually evolving (Barlet & Spohn, 2012); however, focal areas cater to the hard of hearing and those with motor impairments. Large companies such as Microsoft have produced peripherals that enable physically disabled individuals to play video games using adaptive hardware (Spencer, 2018). However, there has been minimal research into accessibility methods suitable for those with cognitive impairments (Brown et al., 2011). Researchers like Yeun et al. have outlined that, "A significant number of people encounter barriers when playing

games due to a disability. Accessibility problems may include the following: (1) not being able to receive feedback; (2) not being able to determine in-game responses".

Through exploring accessibility and ASD, one of the main areas of literature is how to support and encourage diversity within the games industry. This would involve analyzing different variant gamer's abilities and facilitating them every need (Bierre, et al., 2019). When a user begins playing a video game for the first time, they met with the onboarding process, which is a core level design component for any game (Byrne, 2005). Onboarding is a method used to educate users on the fundamentals required to play the game. It introduces game mechanics, tools, and the necessary skills to be successful at the game. At a glance, onboarding is user experience and first impressions (Chou, 2014). User experience, however, encompasses how the user perceives and interacts with their game environment (Barlet, 2014). Researches like Hodent suggest creating a lucrative user experience, "Video game developers must take into account the perception, memory and attention limitations of the brain, as well as the emotions and motivation felt by the players." As mentioned previously, those on the Autistic spectrum perceive the world differently to neurotypical people and have difficulty understanding non-verbal cues. The researcher would like to theorize that this difference in perception would extend to the Autistic user's perception of a game environment and, if true, result in overlooking signals and other non-verbal cues used by developers to drive game flow and narrative.

Researchers like Marco et al. (N.D) have stated that "*What does appear to be common to individuals across the spectrum are the atypical behavioral responses to sensory information."* As a result, the researcher would also like to consider the negative sensory feedback ASD persons may experience when playing video games. Considering everyday stimuli may prove difficult for someone on the Autistic spectrum, it is reasonable to assume that these difficulties would also present while playing video games. Researchers like Mazurek et al. have outlined that, "Research has not yet examined the perspectives of individuals with ASD themselves on this topic" (Mazurek, et al. n.d.). As such, the researcher of this study would like to conduct a thorough investigation into this subject area using both primary and secondary sources to understand the subject further while exploring two key areas:

1. A perspective of video games from individuals who have ASD and their needs
2. To gain further insight to discover if Autistic users' experience difficulty reading non-verbal cues within a gaming environment using VR

These two critical particular research areas will set the scope for the over-arching aim of this project, focusing on VR and how cues within gaming can be deployed to assist **Autism spectrum disorder** (ASD) users in improving gameplay.

LITERATURE REVIEW

Playing video games allows us to partake in experiences which individuals would not be able to otherwise and provides escapism from the mundanity of everyday life (Pang, 2017). Researchers like Granic, Lobel, & Engels, (2014) and Lobel, Engels, Stone, & Granic, (2019) suggests that players can transfer skills gained through repeat gaming exercises to real-life applications (Hertzog, et al. 2009; Owen et al., 2010).

Diversity in video games is currently a focal point in the games industry, with large studios making a conscious effort to support underrepresented people (Griffiths, 2002; Johnson, 2013; Chess, Evans, & Baines, 2017). This new approach towards inclusivity focusing on racial diversity, opportunities, and identifying who is playing the games across the world is helping to shape the next generation of characters (Stuart, 2017; Passmore, Yates, Birk, & Mandryk, 2017). Disability visibility is also garnering much attention from the mainstream media (Resene, 2017) and research (Gent, 2015); large movements, particularly online, endeavor to push content onto the internet to highlight ableism and inclusivity to support and encourage disabled individuals (Disability Visibility Project, 2019; Hemmann, 2020). These developments highlight the importance and demand for a more inclusive games industry; developers have a moral and ethical obligation to consider the needs of their consumers (Barlet & Spohn, 2012; Passmore, Yates, Birk, & Mandryk, 2017).

Video Game Accessibility

With the rise of video game culture and disability awareness movements, how video games are designed is changing (Gaddes, 2018; Disability Visibility Project, 2019; Hemmann, 2020). Large companies such as Microsoft have considered the needs of disabled gamers when designing game experiences (Gerling, Livingston, Nacke, & Mandryk, 2012). However, Microsoft and others who have attempted such inclusivity have placed a keen focus on physically disabled gamers through the development of adaptive hardware/controller (AH/C) (Ibrahim, 2011; Wouters, Downs, Carter, & Moere, 2015; news.microsoft, 2020). AH/C was designed to cater to those who have experienced difficulties through the loss of limbs or have motor impairments such as Parkinson's disease (Parker, 2018). Though this approach to game accessibility is essential and should continuously be developed upon, these methods do not address the barriers those with cognitive impairments face when playing games (Bierre et al., 2019).

Barlet & Spohn, (2012), suggested other, less explored approaches to game accessibility in their document '*Includification*.' Their comprehensive publication was intended as a framework and sent to developers around the world. The authors hoped that their in-depth research would encourage developers to consider the needs of disabled gamers when designing game experiences. Accessibility methods outlined in the text suggest that features such as user interface modularity, subtitles, and multiple difficulty settings are compelling ways to reach disabled gamers. However, these methods do not adequately address all the needs the full range of disabilities

among gamers (Kochar, n.d.; Bierre, Chetwynd, Ellis, Hinn, Ludi, & Westin, 2005; Scott & Ghinea, 2013; Turner, Velloso, Gellersen, & Sundstedt, 2014; Cairns, Power, Barlet, & Haynes, 2019).

Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is an umbrella term for a range of cognitive impairments that affect a person's ability to communicate with others, interact socially, and influence their interests and behavioral patterns (Autism org uk, 2016). Those with Autism perceive the world differently to neurotypical people in a way that can be overwhelming and cause considerable emotional distress. For some individuals with Autism, everyday stimuli such as crowded public places (Falkmer et al. 2015), lighting (Grandin, 2009), sounds (Boddaert et al. 2003), and even touch (Kaiser et al. 2015) can be extremely unpleasant and, in some cases, painful (Marco et al., 2011). Individuals who have high-functioning Autism may appear outward and intelligent, often initiating communication and social interaction (Holland, 2018). These persons can typically take care of themselves and carry out rudimentary tasks without assistance, whereas others may need daily care. Strickland (1997) stated, "*As adults, about two-thirds of persons with Autism remain severely disabled and unable to provide even basic personal care*."

Autistic users are more so attracted to video games (Rigney, 2012) than their neurotypical peers, with more Autistic males showing interest in video games than their female counterparts (MacMullin, Lunsky & Weiss, 2015; Health24, 2013). Playing video games not only allows us to partake in new experiences but also gives us a great deal of control over those experiences (Mazurek & Engelhardt, 2013). For those with ASD, this is just one of the many plausible attractions; users can immerse themselves in a video game and play it on their terms, enabling them to practice skills without outside pressures. Video game worlds are visually stimulating, organized, and Autistic users can escape the chaos of the outside world, a place that too many of these individuals are confusing and intimidating (Becker, 2019). Some researchers have speculated that though video game worlds may be busy, they are within the confines of a relatively small screen allowing Autistic users to hyper-focus on tasks and shut out unpleasant outside noise (Thomas, 2015). Those with Autism are hardwired for logical thinking. Researchers such as Cross (2018) support this knowledge and suggest that an, "*If this happens, this is the expected outcome*" mindset is the kind of consistency and reliability that resonates with Autistic gamers. Though Autistic people are attracted to games and various researchers have examined why that is, there have been limited studies into the perception of video games from these users (Mazurek, Engelhardt & Clark, 2015). This suggests that researchers understand why Autistic users frequently use video games but have little understanding of how they interpret and understand game mechanics and surroundings.

Researchers have suggested plausible issues those with cognitive impairments may face when playing games. Yuan, Folmer & Harris (2010) highlighted that "*Problems may include: (1) not being able to receive feedback; (2) not being able*

to determine in-game responses". Considering this, developers would be able to reach gamers with cognitive impairments if suitable design framework for those with ASD were established and used by developers. Knowing those with Autism react unusually to stimuli in everyday surroundings, it is reasonable to assume that these individuals would also be affected while playing video games. For example, jarring sounds, repetitive patterns, and sequences are just some of the ways. Autistic people can experience sensory overload, an extremely distressing occurrence in which the person experiences more input than their senses can handle. Such features of which are typically present in video games and may affect other users, for example, those with Epilepsy (Ferrie et al. 1994). Sensory overload can lead to concerning symptoms such as; difficulty focusing, irritability, and anxiety (Watson, 2018). As a result, users experiencing sensory overload would be less receptive to methods used by developers to teach game mechanics and engage the player. Frauenberger, Spiel, & Makhaeva, (2019) and Tang, Chen, Falkmer, Bölte, & Girdler, (2019) has similar thoughts to (Watson, 2018) and indicates that design principles and theories should be taken into consideration when looking at supporting autistics individuals.

Level Design Principles and Theory

On-boarding is a technique used in level design to teach players game mechanics in a controlled environment before presenting challenges (Chou, n.d.). Mechanics that are poorly implemented may confuse those with cognitive impairments, and if so, cause the player to fail to understand how a game works. This disconnects between the player and the developer's intentions pose a potential barrier to gameplay progression. It is essential to consider that level design relies heavily on the non-verbal cues used by developers to drive game flow and narrative. Frauenberger, Spiel, & Makhaeva, (2019) and Tang, Chen, Falkmer, Bölte, & Girdler, (2019) builds upon this and indicates that levels designs should also focus on maintaining social interactions to assist them to remediating social skills.

According to Carrington, et al. (2019) an example of supporting autistic social interaction would be the through the use of sign-posting and subtle techniques, which in the level design can be used to subconsciously guide the player through a game environment toward their objective(s) (Wright, 2019). Considering those on the spectrum have difficulty picking up on non-verbal cues in real-life scenarios (Yavuz, Selçuk & Korkmaz, 2019), it is reasonable to assume that this difficulty, much like sensory distress, would extend to their perception of a game environment (Kean, 2014). Regarding the perspective of video games from Autistic users, researchers such as Mazurek et al. have identified that "*Research has not yet examined the perspectives of individuals with ASD themselves on this topic*." These issues address the need for a clearer understanding of how Autistic users perceive game surroundings, non-verbal cues they can interpret, which ones they may have difficulty understanding, to discern practical design considerations to cater to this specific disability. Implementation of Universal Design (UD) is one-way developers can move towards designing games so all users may thrive regardless of ability or circumstances (Maisel et al. 2017). Researchers

such as Mustaquim & Nyström (2019), among others, highlight the importance of this concept. Universal Design, when applied to general game development, is the process of designing a game so that everyone may succeed to the best of their ability (Anderson, 2010). Researchers like Maskey et al. (2019) and Politis, Sung, Goodman & Leahy, (2019) have indicated that another way of assisting autistic users within gaming is through the use of Virtual Reality (VR) as this will aid in empowering individuals, support social stimulation and highlight repetitive behavior in a variety of different situations.

Virtual Reality (VR)

At the time of its creation, VR was developed to push the boundaries of technology. It is no longer considered niche and has since been used across multiple industries for both entertainment (Chirico, Lucidi, De Laurentiis, Milanese, Napoli, & Giordano, 2016), military (Whittenburg, Schall, Wehman, McDonough & DuBois, 2020), education (Costello, 2020) and scientific research (Novotny, Tveite, Turner, Gatesy, Drury, Falkingham & Laidlaw, 2019). At present, the development of VR games is a focal point in the video games industry. Significant gaming platform Steam, which sees *'forty-seven million daily users'* (Felon, 2019), which, when released Steam VR mode, enabled users to play a generous selection of titles using their VR equipment (Fenlon, 2019). Steam is also responsible for the creation of VR equipment, "Vive," developed in collaboration with mobile company HTC (Store steampowered, 2016). These developments in the use of VR as entertainment means that other companies are competitively focusing on the development of VR titles for current and next-generation hardware in a race to be at the forefront of VR innovation (Moersen, 2018).

METHODOLOGY

This section examines and focuses in detail the type of study required to answer the following aims:

1. A perspective of video games from individuals who have ASD and their needs
2. To gain further insight to discover if Autistic users experience difficulty reading non-verbal cues within a gaming environment using VR.

The first section of which discusses the origin of the data and the methods used to gather empirical data. These responses enabled the authors to gain valuable insight into the perspective of video games from individuals with ASD and helped shape the foundation of an accessibility toolkit to support users. The use of participatory design methods to influence software development is supported by Simonsen & Robertson (2013), among others.

The second section of the methodology delves into the approaches taken when designing the VR game prototype, why the design was chosen, and explains how the prototype was created using the software engine. It also provides insight into how

the creation of the game prototype followed participatory design methods to shape the design.

The author used thirty-two participants to undertake this experiment. The candidates varied in age, skills, education/discipline; this enables a diverse cross-section to be analyzed. Testing included the use of Qualitative and Quantitative analysis to check the impact of the primary responsibility of the test participants while using secondary sources (Getchell, et al. 2012) for supportive mechanism.

ANALYSIS OF INTERACTION

This section examines some of the responses provided by those who completed the questionnaire to assist in answering research aim

1. A perspective of video games from individuals who have ASD and their needs

Preliminary Questionnaire

The questionnaire consisted of three parts. The first asked a series of demographic questions to gain an understanding of the background of the participant. Questions related to their age band, gender identity, and the highest level of education undergone. The second section delved into Virtual Reality, and if they had previously experienced VR.

Further questions set out to investigate the participant's perspective of video games, drawing from previous experience. Questions asked what genre they felt most drawn to, if they had become lost in a video game or struggled to understand the gameplay, etc. The third and final section was specific to ASD, asking questions relating to sensory experiences to understand further if video games can cause distress to those on the spectrum. The researcher incorporated Participatory Design methods to influence design; researchers such as Benton et al. (2012), suggest that "This approach can also potentially result in more innovative technologies." In total, 32 responses recorded for the preliminary questionnaire.

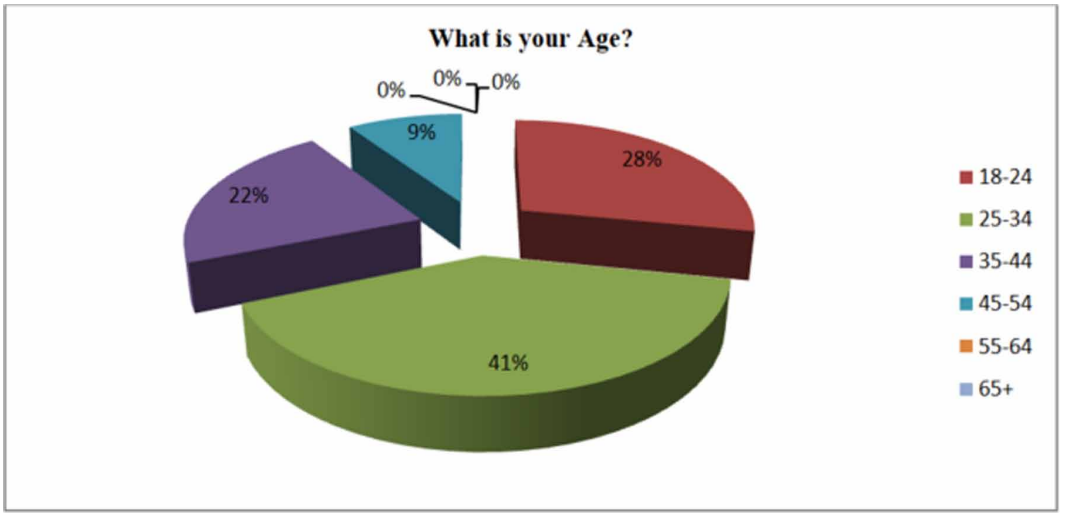
Age

Recorded data shows that the largest age group was those aged 25-34, making up 41% of all respondents. The second-largest demographic was 18-24, amounting to 28%, followed by 35-44 at 22%. There were just three responses recorded from the 45-54 age groups, making up 9% and no respondents who fell into the 55-64 and 65+ categories; please see Figure 1, 'what is your age.'

Gender

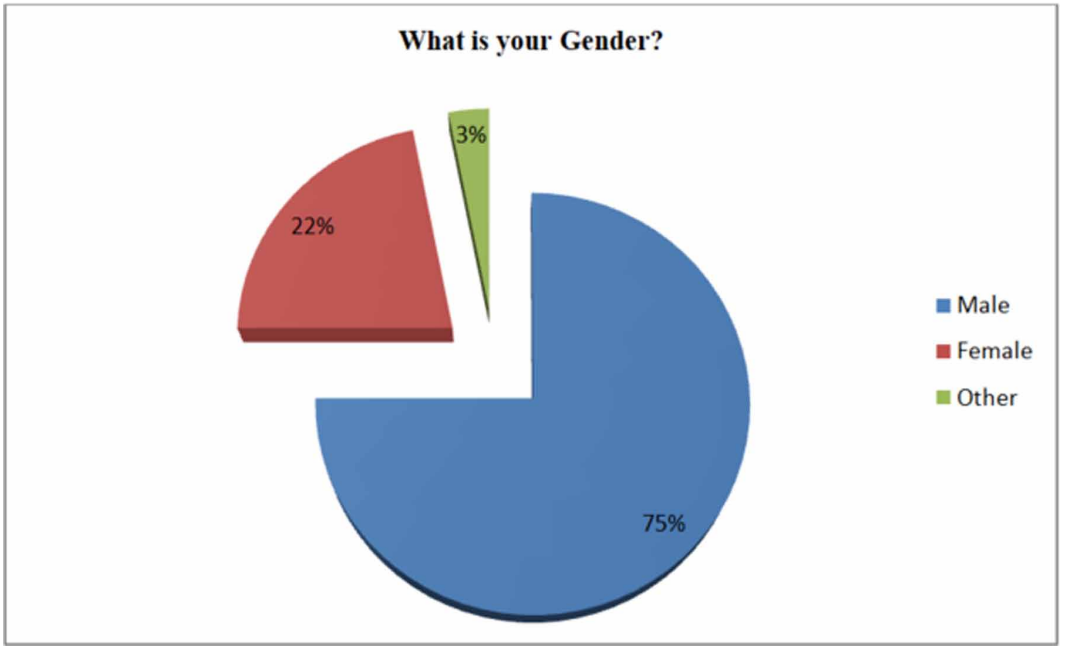
More than half of those who answered the questionnaire were male. In total, 75% of respondents were male, 22% female, and 3% identified as another gender as indicated in Figure 2, what is your gender. When distributing the questionnaire, the researcher reached out to those with ASD who play video games. As such, the researcher

Figure 1. What is your age



anticipated figures which would lean towards a male-dominated response. Literature indicates that Autistic males are most attracted to video games (Mazurek & Engelhardt, 2013), which supports the preliminary finding of this current study.

Figure 2. What is your gender



Highest Level of Education

Of those who responded, 46.9% stated their highest level of education was Bachelor's Degree (BA, BS, etc.). The second most significant response was for Further Education (A-Levels, BTEC, etc.), which amounted to 43.8% of all responses. There were three recorded responses from those with post-graduate Master's Degrees, amounting to 9.4% and no responses for the Secondary (High) School or Doctorate (e.g., Ph.D.) categories. For a graphical representation of these percentages, please see Figures 3 and 4.

Video Game Usage

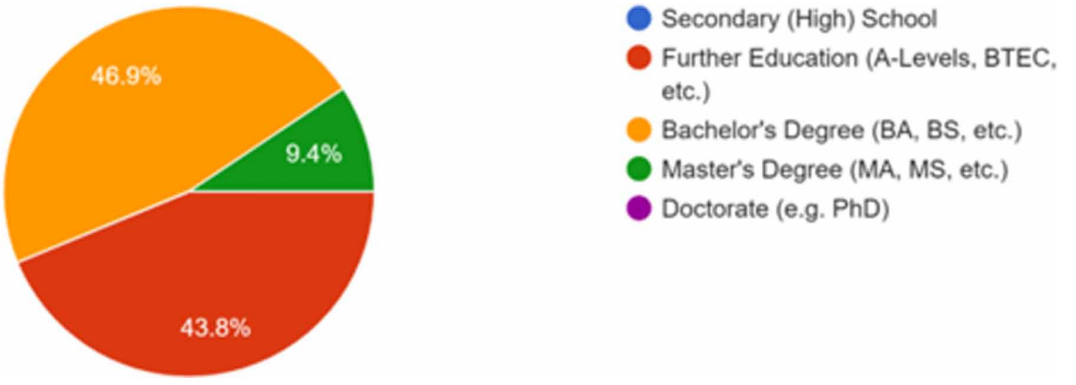
The researcher asked how long participants played video games daily in hours. Of those who responded, 38% replied with 2-3 hours per day, 31% said 1-2 hours a day, 3-4 hours, and more than 4 hours per day were equal at 16%. There were no responses recorded for less than 1 hour per day, which can be seen in Figure 5, hours played.

Video Game Genre

This question set out to investigate participants' preferred genre of the video game by providing seven categories to choose from and an option for the participant to add a custom genre that was not listed. There was an overwhelming response by those who preferred the 'Role-playing genre' amounting to 72% of responses, 22% said they preferred 'Adventure' games.

There was one response recorded for both the 'Shooter' and 'Action' genres amounting to 3% each, and no responses recorded for 'Platformer' and 'Sports' genres. Participants did not make use of the custom genre field. Further research was carried out into the anomaly within the disperse spread of data, which according to Smyth, (2007), individuals with ASD find that playing role-playing game genre is enjoyable, offers them the abilities to help others through making friends and final socialize within a virtual world.

Figure 3. Pie chart on the highest level of education you have completed



Virtual Reality Experience

This question asked participants if they had experienced Virtual Reality before. Of the 32 recorded responses for the questionnaire, a staggering 31 responses replied with 'Yes,' amounting to 97%, and one response for 'No' making up just 3%. Further analysis of the results belonging to this question shows that through VR, individuals can overcome fear, understand social settings, adjust behavior, or even reduce anxiety and phobias (Parsons & Mitchell, 2002).

Figure 4. Bar chart on the highest level of education you have completed

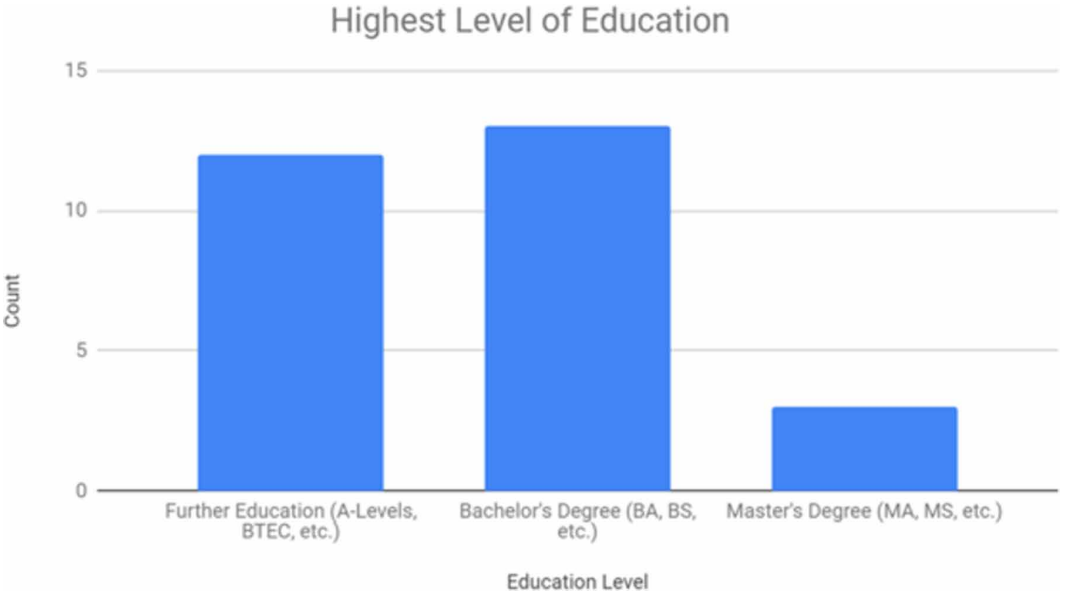
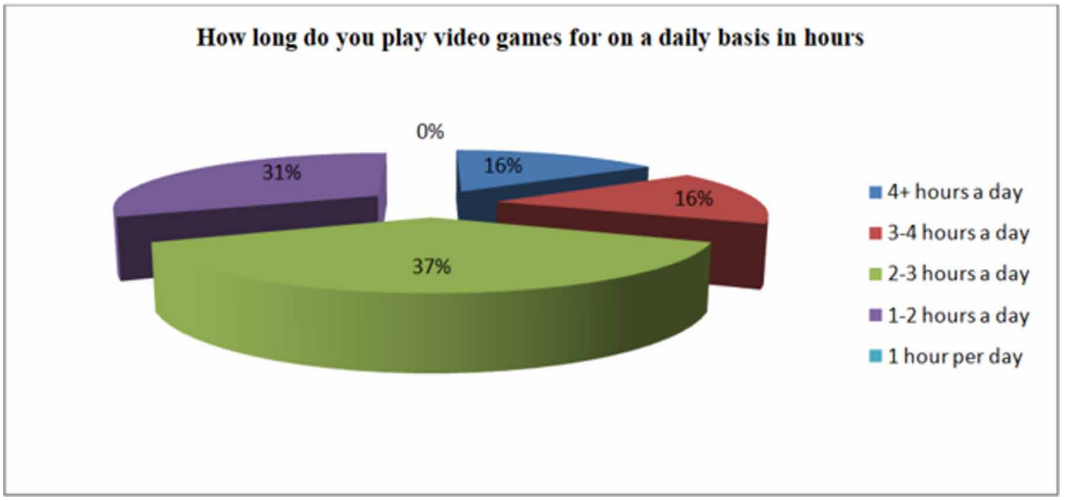


Figure 5. Hours played



Sensory Distress – Qualitative Response

When asking respondents if they had previously experienced sensory distress while playing a video game, the researcher anticipated some responses to indicate users had. Twenty-seven of the thirty-two individuals who took part in the preliminary questionnaire indicated they had experienced sensory distress while playing a video game. Participants highlighted features such as; jarring sounds, flashing pictures, game difficulty, the screen shakes, and poorly implemented game mechanics as sources of this distress. Notable responses included, "Screen shakes, moving background objects, parallax scrolling, etc. make it difficult to concentrate", "Too much going on at the same time on screen," and, "I struggle to keep up with fast gameplay and prefer to take things at my own pace." The authors considered these findings during the development of the VR prototype by avoiding such triggers, which again supported the work that was carried out by (Lahiri, Bekele, Dohrmann, Warren, & Sarkar, 2013).

Game Accessibility

This question set out to answer if users had previously enabled accessibility in a video game; however, referring to the graphical representation in Figure 6, the majority indicated no.

Final Section of Testing

The final section of testing looks at answering the following research aim:

B) To gain further insight to discover if Autistic users experience difficulty reading non-verbal cues within a gaming environment using VR.

To achieve this author(s) set up the following Test Procedures:

The researchers set up a VR-ready laptop and provided the participants with an HMD (Head-Mounted Display). Participants were asked to find a gaming objective hidden in a forest environment within a 3-minute time window.

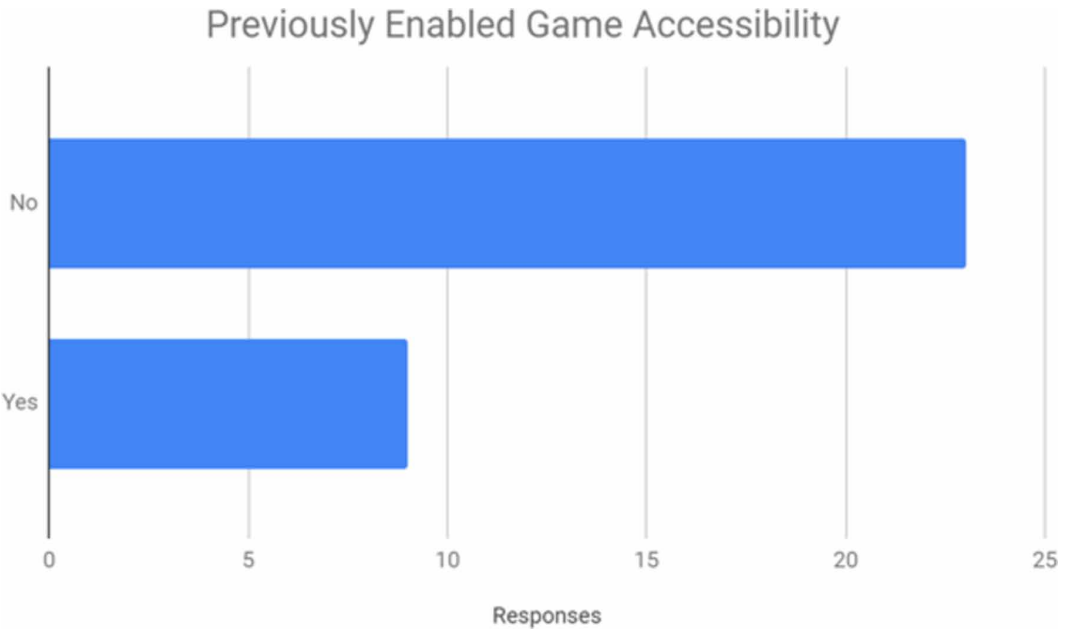
This time frame coincided with the day/night cycle of the game engine, giving users both a reasonable amount of time to find their objective and experience slow transitional environment changes.

During the "day," the environment is vibrant; path and subtle walkways are much more visible to the player. Subtle background sounds hint the user in the right direction.

At "night" fireflies (particle systems) spawn at specified locations to aid user navigation towards the objective, and directional audio cues are much more prominent.

To assist with the breakdown of the gaming environment, quantitative methods were used through Google forms to gather data analysis, which is broken down into Game Play, Verbal Cues, & VR User Experience.

Figure 6. Using in-game Accessibility features



Game Play – Objective of the Testing

Results show that most participants became lost when exploring the forest environment, with (68%) failing to find their objective within the allocated time, while the other 32% of test candidates found the layout and features of the testing were appropriate.

Game Play – Navigation

Participants were asked during testing to navigate the testing environment without being prompted by the authors to which 50%, who found this adequate while the other half difficult. Further additional analysis, while in-game played showed that 84% failed to follow the ***non-verbal cues*** used by the developers to sign-post the route towards the objective, while 16% indicated they used verbal cues to work out a suitable pathway within the given time limit.

Verbal Cues – Qualitative Response

Participants were asked to indicate features that inspired them to move toward a specific location within the environment and provide examples. Notable answers highlighted, "I followed distant animal sounds," "Interesting plants and sounds," "Wind and birds mostly." Even though within the gaming setting, the authors were looking at **Visual Cues**, some of the responses from qualitative does indicate that Autistic users are more receptive to **audio** rather than **visual cues**. Researchers such as Stiegler & Davis (2010), validates the author's research by indicating that Autistic users are more sensitive to sound. When asked what features users would like to see later added to the testing environment, frequent responses included, "An inventory

system," "Enemies," "A storyline," and, "Some environmental storytelling to explain why the player has found themselves in that situation." These features are typically present in Role-playing games which Smyth, (2007) indicated that individuals with ASD find games belonging to this genre more enjoyable.

Virtual Reality User Experience of the Proposed Accessibility Framework (PAF)

This question set out to investigate users' experience with Virtual Reality Framework by asking them of their experience on a scale from 1-5 (1= Not at all effective, 5= extremely effective).

Referring to Figure 7, 50% of the test candidates thought the idea of using ***navigation*** and ***game cues*** were significant within the testing prototype. However, as seen 25% of individuals selected somewhat useful due to the factors of lacking: "them the ability to make friends through helping others and socializing within a virtual world" to "*the environment not having a story*," the final, 25% suggested that the environment was not at all productive and more details should be on "*steering the players through the game with Sound and Pop-up's*."

THE PROPOSED ACCESSIBILITY FRAMEWORK

Through extensive research, the authors have composed the following accessibility framework in addition to highlighting design considerations to cater to those with Autism Spectrum Disorder when designing game experiences. Current literature on ASD, game accessibility, VR, and level design principles and theory alongside the results from the preliminary and user feedback questionnaires made the creation of this framework possible. The framework is not exhaustive and demonstrates the essential components developers should implement into their video games to support a multitude of ASD needs. For the Proposed Accessibility Framework (PAF), please see Figure 8.

Perception Markers

When enabled, this feature places a series of markers above all significant in-game objects. A cross symbol is referring to objects and other assets that may pose a threat to the player. Examples include; enemies, harmful elements such as fire, and similar dangerous obstacles. A circle corresponds to neutral encounters, non-threatening static or moving objects such as allied characters, friendly players, etc...

That cannot cause harm to the player. A square symbol should indicate containers the player can open, and finally, a triangle symbol should distinguish other interactable objects. For example, buttons, switches, doors, etc. Professional Level Designers have highlighted the importance of shape theory in level design and everyday objects and how the use of various shape types may impact a player's psyche (Pears, 2019). This feature borrows elements from traditional shape theory, and how humans are more (or less) receptive to being attracted to or apprehensive of an object based on its underlying shape (Velarde, n.d; Yavuz, Selçuk & Korkmaz, 2019; Carrington, et al. 2019). Featuring perception markers would enable those with Autism to distinguish

Figure 7. Experience of VR PAF Framework

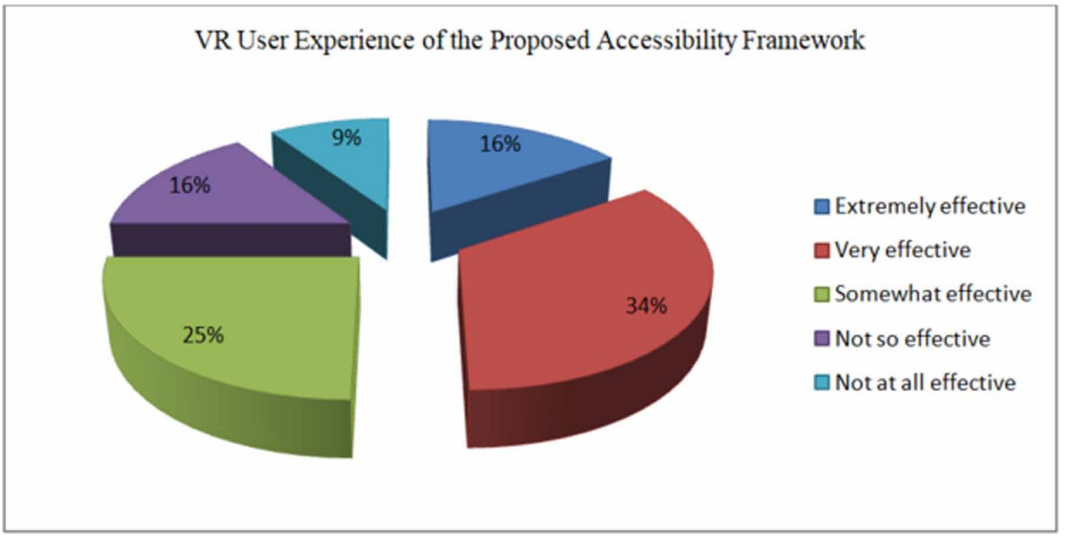


Figure 8. Proposed accessibility framework (PAF)

objects they can interact with from non-interactable objects developers have used to populate a game environment for decorative purposes. This design consideration would not only aid those with ASD who may become confused by busy surroundings but also keep them on track by subtly hinting towards mechanics, which may aid gameplay progression. Additionally, research suggests that those with ASD are less inclined to perceive danger due to their sensory processing, and visually outlining threats in a video game is one approach developers can take to reach those with this kind of cognitive impairment (Sicile-Kira, 2012).

Player Input Markers

When enabled, this feature allows the player to create their markers and visual notes within a game environment. This could be done by allowing the player to hold down a button and drawing using their input device. The need to enable this feature is purely situational and may perhaps be most beneficial to players in big open-world games to aid navigation and gameplay progression. Researchers such as Moreno and O'Neal (2000) suggest that "*People with autism have trouble with organizational skills, regardless of their intelligence and/or age" and that "Aid should be provided in the least restrictive way possible*." Although many developers have developed systems that allow players to place custom waypoints on an in-game map, this approach is somewhat limiting and only allows the use of pre-determined symbols (Barlet & Spohn, 2012). Inclusion of custom play input markers would allow players to add as much or little visual assistance as they require keeping them on track.

Flexible Subtitles

Subtitles should be considered an essential accessibility feature in any media with video for the user to follow. Not only does it aid those with sight problems, but it is also an essential feature for individuals with cognitive impairments. Those with Autism have trouble processing sound and images, particularly in busy environments; a game is just that but in a confined space (Thomas, 2015). The inclusion of subtitles allows these users to immerse themselves in a game and differentiate background audio from meaningful dialogue.

Furthermore, subtitles should have a solid black background, so they are bold and visually stand out from the rest of the screen content; this approach is universally considered best design practice for subtitles (Palay, 2017; Costello, Lambert, & Kern, 2019). Notably, and more unique to this toolkit, the player should be able to change the font of the subtitles choosing from a small selection of Sans Serif fonts. Sans Serif fonts are simplistic, without the decorative flair, and are the most accessible fonts to read as the human brain spends less time identifying the shape when compared to Serif fonts (Scribe com au, 2019).

Atmospheric VFX Control

The ASD or players with disabilities should be able to disable atmospheric VFX (Visual Effects) such as; snow particles, dust, leaves, moving debris, etc. The outlined example of VFX falls under the category of repetitive patterns and visual distractions,

which are known to trigger sensory overload in those with Autism (Autism.org.uk, 2019). As previously outlined, sensory overload is a distressing experience in which the individual experiences more input than their senses can handle. Sensory overload can lead to concerning symptoms such as; difficulty focusing, irritability, and anxiety (Watson, 2018). As a result, users experiencing sensory overload would be less receptive to methods used by developers to teach game mechanics and engage the player. Allowing the user control over which VFX is featured provides an opportunity for controllable stimuli in a video game environment to reduce anxiety, a method supported by Strickland (1997), among others.

CONCLUSION

Throughout the research, the authors tried to strive for a way to show that video games for Autism Spectrum Disorder play an essential role in the lives of many individuals. With the rise of video game culture and disability awareness movements, how video games are designed is changing (Gaddes, 2018; Disability Visibility Project, 2019; Hemmann, 2020). However, there is still limited research into accessibility impairments and disabilities with how those with ASD interpret video game surroundings. Research from Costello, Lambert & Kern (2019) and this current research does indicate that players still aim for **Visual Cues**, but for the majority, the aid of **audio** was more beneficial and less distracting, as seen in Figure 7. The preliminary framework being suggested here within this research, the Proposed Accessibility Framework (PAF) was aimed at supporting individuals with ASD.

The PAF framework indicates a positive way forward to using a reliable medium for working with ASM to control stimuli. Video games could provide much needed cognitive and perceptive benefits to autistic users if these users can be reached at the same level playing field as neurotypicals. The preliminary results from the data analysis sections show that some features belonging to the PAF need work and further primary investigations is ongoing towards more massive data sets and more advanced testing environments. One of the key points from this research is that as highlighted above is that by applying a mixture of **Visual** and **Audio Cues** into the game design will assist with clearer story-lines throughout the game, and additional gaming missions, quests, and unlocking stages. This supports some of the additional research carried out on previous research about Visual Cues (Costello, Lambert & Kern, 2019). Future work and progression within the PAF design are to apply social aspects to enable ASD participants to have the ability to make new friends or feel as if there are helping others. This supports the research from others within the field like (Wright, 2019; Maskey et al. 2019; Politis, Sung, Goodman & Leahy, 2019). Throughout this research, it is apparent that there is a need for design considerations to be established, and more consideration towards sensory distress and accessibility to cater to those with cognitive impairments, which literature indicated there is currently a distinct lack of in the video game industry. Even though the research points out that some participants do not always use the accessibilities features, but having Audio and

Visual Cues built-in could automatically assist in the designs of future games not just in the Triple AAA market but also Indie too.

REFERENCES

Ourgateshead.org/autie-mates. (2020). *Autie Mates*. https://www.ourgateshead.org/autie-mates

Anderson, F. (2010). *How True Universal Design Could Revolutionize Game Development*. Venture Beat. https://venturebeat.com/community/2010/12/02/how-true-universal-design-could-revolutionize-game-development/

Autism.org.uk. (2016). *Autism - National Autistic Society*. Available at: https://www.autism.org.uk/about/what-is/asd.aspx#See

Barlet, H. (2014). *Block design in level design*. Gamasutra.com. Available at: https://www.gamasutra.com/blogs/HuguesBarlet/20140907/225061/Block_design_in_level_design.php

Barlet, M., & Spohn, S. (2012). *A Practical Guide to Game Accessibility*. Includification.com. Available at: https://www.includification.com/AbleGamers_Includification.pdf

Baron-Cohen, S., Scott, F., Allison, C., Williams, J., Bolton, P., Matthews, F., & Brayne, C. (2009). Prevalence of autism-spectrum conditions: UK school-based population study. *The British Journal of Psychiatry*, *194*(6), 500–509. doi:10.1192/bjp.bp.108.059345 PMID:19478287

Becker, L. (2019). *With autism, a game is not just a game | Autism Support Network*. Autismsupportnetwork.com. http://www.autismsupportnetwork.com/news/autism-game-not-just-game-378493242

Benton, L., Johnson, H., Ashwin, E., Brosnan, M., & Grawemeyer, B. (2012). Developing IDEAS: Supporting children with Autism within a participatory design team. *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*. https://www.researchgate.net/publication/254005128_Developing_IDEAS_Supporting_children_with_Autism_within_a_participatory_design_team

Bierre, K., Chetwynd, J., Ellis, B., Hinn, D. M., Ludi, S., & Westin, T. (2005). Game not over: Accessibility issues in video games. In *Proc. of the 3rd International Conference on Universal Access in Human-Computer Interaction* (pp. 22-27). Academic Press.

Bierre, K., Ellis, B., Chetwynd, J., Hinn, D., Ludi, S., & Westin, T. (2019). *Game Not Over: Accessibility Issues in Video Games*. https://www.researchgate.net/publication/267403944_Game_Not_Over_Accessibility_Issues_in_Video_Games

Boddaert, N., Belin, P., Chabane, N., Poline, J., Barthélémy, C., Mouren-Simeoni, M., Brunelle, F., Samson, Y., & Zilbovicius, M. (2003). Perception of Complex Sounds: Abnormal Pattern of Cortical Activation in Autism. *American Journal of Psychiatry*, *160*(11), 2057-2060. https://ajp.psychiatryonline.org/doi/full/10.1176/appi.ajp.160.11.2057

Brown, D. J., McHugh, D., Standen, P., Evett, L., Shopland, N., & Battersby, S. (2011). Designing location-based learning experiences for people with intellectual disabilities and additional sensory impairments. *Computers & Education*, *56*(1), 11–20. doi:10.1016/j.compedu.2010.04.014

Buescher, A., Cidav, Z., & Knapp, M. (2014). *Costs of Autism Spectrum Disorders in the United Kingdom and the United States*. Jama Network. https://jamanetwork.com/journals/jamapediatrics/fullarticle/1879723?utm_source=Silverch

Cairns, P., Power, C., Barlet, M., & Haynes, G. (2019). Future design of accessibility in games: A design vocabulary. *International Journal of Human-Computer Studies*, *131*, 64–71. doi:10.1016/j.ijhcs.2019.06.010

Cankaya, S., & Kuzu, A. (2010). Investigating the characteristics of educational computer games developed for children with autism: A project proposal. *Procedia: Social and Behavioral Sciences*, *9*, 825–830. doi:10.1016/j.sbspro.2010.12.242

Carrington, S. J., Barrett, S. L., Sivagamasundari, U., Fretwell, C., Noens, I., Maljaars, J., & Leekam, S. R. (2019). Describing the profile of diagnostic features in autistic adults using an abbreviated version of the Diagnostic Interview for Social and Communication Disorders (DISCO-Abbreviated). *Journal of Autism and Developmental Disorders*, *49*(12), 5036–5046. doi:10.1007/s10803-019-04214-7 PMID:31494785

Centers for Disease Control and Prevention. (2018). *Data and Statistics | Autism Spectrum Disorder (ASD) | NCBDDD | CDC*. https://www.cdc.gov/ncbddd/autism/data.html

Chess, S., Evans, N. J., & Baines, J. J. (2017). What does a gamer look like? Video games, advertising, and diversity. *Television & New Media*, *18*(1), 37–57. doi:10.1177/1527476416643765

Chirico, A., Lucidi, F., De Laurentiis, M., Milanese, C., Napoli, A., & Giordano, A. (2016). Virtual reality in health system: Beyond entertainment. a mini-review on the efficacy of VR during cancer treatment. *Journal of Cellular Physiology*, *231*(2), 275–287. doi:10.1002/jcp.25117 PMID:26238976

Chou, Y. (2014). *Onboarding Experience Phase in Gamification*. Yu-kai Chou: Gamification & Behavioral Design. https://yukaichou.com/gamification-study/4-experience-phases-gamification-2-onboarding-phase/

Chou, Y. (n.d.). *4 Experience Phases in Gamification (#2): The Onboarding Phase*. https://yukaichou.com/gamification-study/4-experience-phases-gamification-2-onboarding-phase/

Costello, R. (2020). Gamification Strategies for Retention, Motivation, and Engagement in Higher Education: Emerging Research and Opportunities. IGI Global.

Costello, R., Lambert, M., & Kern, F. (2019). How Can Accessibility for Deaf and Hearing-Impaired Players be Improved in Video Games? *International Journal of R&D Innovation Strategy*, *1*(1), 16–32. doi:10.4018/IJRDIS.2019010102

Cross, T. (2018). *Video games and autism – what is the attraction?* The Art of Autism. Available at: https://the-art-of-autism.com/video-games-and-autism-what-is-the-attraction/

Disability Visibility Project. (2019). *About*. https://disabilityvisibilityproject.com/about

Falkmer, M., Barnett, T., Horlin, C., Falkmer, O., Siljehav, J., Fristedt, S., Lee, H., Chee, D., Wretstrand, A. & Falkmer, T. (2015). *Viewpoints of adults with and without Autism Spectrum Disorders on public transport*. 10.1016/j.tra.2015.07.019

Fenlon, W. (2019). *Steam now has 90 million monthly users*. pcgamer. https://www.pcgamer.com/uk/steam-now-has-90-million-monthly-users/

Ferrie, C., De Marco, P., Grünewald, R., Giannakodimos, S., & Panayiotopoulos, C. (1994). Video game induced seizures. *Journal of Neurology, Neurosurgery, and Psychiatry*, *57*(8), 925–931. doi:10.1136/jnnp.57.8.925 PMID:8057115

Frauenberger, C., Spiel, K., & Makhaeva, J. (2019). Thinking outsideTheBox-designing smart things with autistic children. *International Journal of Human-Computer Interaction*, *35*(8), 666–678. doi:10.1080/10447318.2018.1550177 PMID:31057337

Gaddes, M. (2018). *5 ways accessibility in video games is evolving*. AbilityNet. https://www.abilitynet.org.uk/news-blogs/5-ways-accessibility-video-games-evolving

Gent, E. (2015). For your eyes only. *Engineering & Technology*, *10*(9), 56–59. doi:10.1049/et.2015.0920

Gerling, K., Livingston, I., Nacke, L., & Mandryk, R. (2012). Full-body motion-based game interaction for older adults. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 1873-1882). doi:10.1145/2207676.2208324

Getchell, N., Miccinello, D., Blom, M., Morris, L., & Szaroleta, M. (2012). Comparing energy expenditure in adolescents with and without autism while playing Nintendo® Wii™ games. *GAMES FOR HEALTH: Research, Development, and Clinical Applications*, *1*(1), 58–61. doi:10.1089/g4h.2011.0019 PMID:26196433

Granic, I., Lobel, A., & Engels, R. C. (2014). The benefits of playing video games. *The American Psychologist*, *69*(1), 66–78. doi:10.1037/a0034857 PMID:24295515

Griffiths, M. D. (2002). The educational benefits of videogames. *Education for Health*, *20*(3), 47–51.

Health24. (2013). *Autistic boys more attracted to video games*. https://www.health24.com/Medical/Autism/About-autism/Autistic-boys-more-attracted-to-video-games-20130730

Hemmann, K. (2020). Link Is Not Silent: Queer Disability Positivity in Fan Readings of The Legend of Zelda: Breath of the Wild. In Manga Cultures and the Female Gaze (pp. 125-145). Palgrave Macmillan, Cham.

Hertzog, C., Wilson, R., Kramer, A., & Lindenberger, U. (2009). *Enrichment Effects on Adult Cognitive Development Can the Functional Capacity of Older Adults Be Preserved and Enhanced?* https://www.researchgate.net/publication/236150309_Enrichment_Effects_on_Adult_Cognitive_Development_Can_the_Functional_Capacity_of_Older_Adults_Be_Preserved_and_Enhanced

Hodent, C. (2016). *The Gamer's Brain, Part 2: UX of Onboarding and Player Engagement (GDC16).* https://celiahodent.com/the-gamers-brain-part-2-gdc16/

Holland, K. (2018). *Levels of Autism: Symptoms and Outlook of Severity Levels 1, 2, and 3*. Healthline. Available at: https://www.healthline.com/health/levels-of-autism

Ibrahim, R. (2011). *A conceptual framework for supporting gender inclusivity in games* (Doctoral dissertation). University of Southampton.

Johnson, R. S. (2013). Toward greater production diversity: Examining social boundaries at a video game studio. *Games and Culture*, *8*(3), 136–160. doi:10.1177/1555412013481848

Kaiser, M., Yang, D., Voos, A., Bennett, R., Gordon, I., Pretzsch, C., Beam, D., Keifer, C., Eilbott, J., McGlone, F., & Pelphrey, K. (2015). Brain Mechanisms for Processing Affective (and Nonaffective) Touch Are Atypical in Autism. *Cerebral Cortex (New York, N.Y.)*. Advance online publication. doi:10.1093/cercor/bhv125 PMID:26048952

Kean, R. N. (2014). *An investigation into the efficacy of a game-based learning tool to assist school children with an autistic spectrum condition to overcome sensory difficulties* (Doctoral dissertation). University of Huddersfield.

Kochar, P. (n.d.). *Video Games and Autism: Helpful or Harmful? Madison House Autism Foundation*. Madison House Autism Foundation. Available at: http://www.madisonhouseautism.org/video-games-and-autism-helpful-or-harmful/

Lahiri, U., Bekele, E., Dohrmann, E., Warren, Z., & Sarkar, N. (2013). Design of a virtual reality based adaptive response technology for children with autism. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, *21*(1), 55–64. doi:10.1109/TNSRE.2012.2218618 PMID:23033333

Lobel, A., Engels, R. C., Stone, L. L., & Granic, I. (2019). Gaining a competitive edge: Longitudinal associations between children's competitive video game playing, conduct problems, peer relations, and prosocial behavior. *Psychology of Popular Media Culture*, *8*(1), 76–87. doi:10.1037/ppm0000159

MacMullin, J., Lunsky, Y., & Weiss, J. (2015). Plugged in: Electronics use in youth and young adults with autism spectrum disorder. *Autism*, *20*(1), 45–54. doi:10.1177/1362361314566047 PMID:25694586

Maisel, J., Steinfeld, E., Basnak, M., Smith, K., & Tauke, B. (2017). *Inclusive Design: Implementation and Evaluation* (1st ed.). Routledge. doi:10.4324/9781315712437

Marco, E., Hinkley, L., Hill, S., & Nagarajan, S. (2011). Sensory Processing in Autism: A Review of Neurophysiologic Findings. *Neuropsychiatric Disorders and Pediatric Psychiatry, 69*. Available at: https://www.nature.com/articles/pr9201193

Maskey, M., Rodgers, J., Ingham, B., Freeston, M., Evans, G., Labus, M., & Parr, J. R. (2019). Using Virtual Reality Environments to Augment Cognitive Behavioral Therapy for Fears and Phobias in Autistic Adults. *Autism in Adulthood*, *1*(2), 134–145. doi:10.1089/aut.2018.0019 PMID:31032480

Mazurek, M. (2013). *Gaming with Autism*. The Scientist Magazine®. https://www.the-scientist.com/critic-at-large/gaming-with-autism-39994

Mazurek, M., Engelhardt, C., & Clark, K. (2015). Video games from the perspective of adults with autism spectrum disorder. *Computers in Human Behavior*, *51*, 122–130. doi:10.1016/j.chb.2015.04.062

Moersen, A. (2018). *How Virtual Reality is Revolutionizing the Gaming Industry*. Innovation & Tech Today. Available at: https://innotechtoday.com/virtual-reality-revolutionizing-gaming-industry/

Mustaquim, M., & Nyström, T. (2019). *An Inclusive Framework for Developing Video Games for Learning*. DIVA. Available at: http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-188003

news.microsoft. (2020). *Adaptive Controller*. https://news.microsoft.com/stories/xbox-adaptive-controller/

Novotny, J., Tveite, J., Turner, M. L., Gatesy, S., Drury, F., Falkingham, P., & Laidlaw, D. H. (2019). Developing virtual reality visualizations for unsteady flow analysis of dinosaur track formation using scientific sketching. *IEEE Transactions on Visualization and Computer Graphics*, *25*(5), 2145–2154. doi:10.1109/TVCG.2019.2898796 PMID:30908229

Ortiz de Gortari, A. B., Pontes, H. M., & Griffiths, M. D. (2015). The Game Transfer Phenomena Scale: An instrument for investigating the nonvolitional effects of video game playing. *Cyberpsychology, Behavior, and Social Networking*, *18*(10), 588–594. doi:10.1089/cyber.2015.0221 PMID:26376231

Owen, A., Grahn, J., Hampshire, A., & Stenton, R. (2010). *Putting brain training to test*. Available at: https://www.researchgate.net/publication/43227329_Putting_brain_training_to_test

Palay, S. (2017). *Best Practices for Online Subtitling — EngageMedia*. Engagemedia.org. https://www.engagemedia.org/blog/best-practices-for-online-subtitling

Pang, C. (2017). *Understanding Gamer Psychology: Why Do People Play Games?* Sekg. Available at: https://www.sekg.net/gamer-psychology-people-play-games/

Parker, L. (2018). *Xbox Adaptive Controller Gives Disabled Gamers a Power-Up*. Wired. Available at: https://www.wired.com/story/microsoft-xbox-adaptive-controller/

Parsons, S., & Mitchell, P. (2002). The potential of virtual reality in social skills training for people with autistic spectrum disorders. *Journal of Intellectual Disability Research*, *46*(5), 430–443. doi:10.1046/j.1365-2788.2002.00425.x PMID:12031025

Passmore, C. J., Yates, R., Birk, M. V., & Mandryk, R. L. (2017). Racial diversity in indie games: Patterns, challenges, and opportunities. In *Extended abstracts publication of the annual symposium on computer-human interaction in play* (pp. 137-151). Academic Press.

Pears, M. (2019). *Level Design Library - Shape Theory in Level Design*. YouTube. Available at: https://www.youtube.com/watch?v=wOhuXSZaLH8

Politis, Y., Sung, C., Goodman, L., & Leahy, M. (2019). *Conversation skills training for people with autism through virtual reality: using responsible research and innovation approach*. Advances in Autism.

Resene, M. (2017). From Evil Queen to Disabled Teen: Frozen Introduces Disney's First Disabled Princess. *Disability Studies Quarterly*, *37*(2). Advance online publication. doi:10.18061/dsq.v37i2.5310

Rigney, R. (2012). *For Gamers With Autism, Online Worlds a Cycle of Attraction and Fear*. https://www.wired.com/2012/11/autistic-gamers-autism/

Scott, M. J., & Ghinea, G. (2013). *Promoting game accessibility: Experiencing an induction on inclusive design practice at the global games jam*. arXiv preprint arXiv:1305.4359

Shimabukuro, T., Grosse, S., & Rice, C. (2007). Medical Expenditures for Children with an Autism Spectrum Disorder in a Privately Insured Population. *Journal of Autism and Developmental Disorders, 38*(3), 546-552. Available at: https://link.springer.com/article/10.1007%2Fs10803-007-0424-y#citeas

Sicile-Kira, C. (2012). *What Are the Safety Concerns for People on the Autism Spectrum?* Psychology Today. Available at: https://www.psychologytoday.com/us/blog/the-autism-advocate/201202/what-are-the-safety-concerns-people-the-autism-spectrum

Simonsen, J., & Robertson, T. (2013). *Routledge international handbook of participatory design* (1st ed.). Routledge.

Smyth, J. M. (2007). Beyond self-selection in video game play: An experimental examination of the consequences of massively multiplayer online role-playing game play. *Cyberpsychology & Behavior*, *10*(5), 717–721. doi:10.1089/cpb.2007.9963 PMID:17927543

Spencer, P. (2018). *Accessible Gaming with the Xbox Adaptive Controller - Xbox Wire*. Xbox Wire. Available at: https://news.xbox.com/en-us/2018/05/16/xbox-adaptive-controller/

Steenbergen, L., Sellaro, R., Stock, A., Beste, C., & Colzato, L. (2015). Action Video Gaming and Cognitive Control: Playing First Person Shooter Games Is Associated with Improved Action Cascading but Not Inhibition. *PLoS One*, *10*(12), e0144364. doi:10.1371/journal.pone.0144364 PMID:26655929

Store.steampowered.com. (2016). *HTC Vive on Steam*. Available at: https://store.steampowered.com/app/358040/HTC_Vive/

Strickland, D. (1997). *Virtual Reality for the Treatment of Autism.* Available at: https://pdfs.semanticscholar.org/358e/28df2cb7720b7100811f4aee7af731164b08.pdf

Stuart, K. (2017). *Why diversity matters in the modern video games industry*. The Guardian. Available at: https://www.theguardian.com/technology/2017/jul/18/diversity-video-games-industry-playstation-xbox

Tang, J. S., Chen, N. T., Falkmer, M., Bölte, S., & Girdler, S. (2019). A systematic review and meta-analysis of social emotional computer based interventions for autistic individuals using the serious game framework. *Research in Autism Spectrum Disorders*, *66*, 101412. doi:10.1016/j.rasd.2019.101412

The Guardian. (2018). *New test can detect autism in children, scientists say*. https://www.theguardian.com/society/2018/feb/19/autism-children-blood-urine-test

Thomas, P. (2015). *Autism & Video Games | Dr. Paul*. YouTube. https://www.youtube.com/watch?v=oy0ZGz92Roo

Torrente, J., del Blanco, Á., Moreno-Ger, P., & Fernández-Manjón, B. (2012). *Designing Serious Games for Adult Students with Cognitive Disabilities*. Neural Information Processing. doi:10.1007/978-3-642-34478-7_73

Turner, J., Velloso, E., Gellersen, H., & Sundstedt, V. (2014). EyePlay: applications for gaze in games. In *Proceedings of the first ACM SIGCHI annual symposium on Computer-human interaction in play* (pp. 465-468). doi:10.1145/2658537.2659016

Velarde, O. (n.d.). *The Meaning of Shapes and How to Use Them Creatively in Your Designs*. Visual Learning Center by Visme. Available at: https://visme.co/blog/geometric-meanings/

Watson, K. (2018). *Sensory Overload: Symptoms, Causes, Related Conditions, and More*. Healthline. Available at: https://www.healthline.com/health/sensory-overload

Whittenburg, H. N., Schall, C. M., Wehman, P., McDonough, J., & DuBois, T. (2020). Helping high school-aged military dependents with autism gain employment through project SEARCH+ ASD supports. *Military Medicine, 185*(Supplement_1), 663-668.

Wouters, N., Downs, J., Carter, M., & Moere, V. (2015). Masquerade: Social influence of full-body game interaction on public displays. *Proceedings of DiGRAA Digital Games Research Association*, 19.

Wright, J. (2017). *The Real Reasons Autism Rates Are Up in the U.S.* Scientific American. Available at: https://www.scientificamerican.com/article/the-real-reasons-autism-rates-are-up-in-the-u-s/

Wright, W. (2019). *MasterClass | Will Wright Teaches Game Design and Theory*. MasterClass. Available at: https://www.masterclass.com/classes/will-wright-teaches-game-design-and-theory

Yang, T. R., Wolfberg, P. J., Wu, S. C., & Hwu, P. Y. (2003). Supporting children on the autism spectrum in peer play at home and school: Piloting the integrated play groups model in Taiwan. *Autism*, *7*(4), 437–453. doi:10.1177/1362361303007004009 PMID:14678682

Yavuz, H. M., Selçuk, B., & Korkmaz, B. (2019). Social competence in children with autism. *International Journal of Developmental Disabilities*, *65*(1), 10–19. doi:10.1080/20473869.2017.1346224

Yuan, B., Folmer, E., & Harris, F. (2010). Game accessibility: a survey. *Universal Access in the Information Society, 10*(1), 81-100. https://link.springer.com/article/10.1007/s10209-010-0189-5#citeas

Robert Costello, since 2005, has worked as a researcher within the field of online learning, and in particular (personalised and adaptive learning) while incorporating learning theories and Adaptive Information Retrieval (AIR). His research trends do vary to incorporate Postgraduates, which has mostly involved tailoring system designs for community collaboration, MLearning and gamification within Higher Education. Over the last 13 years, he has taught a variety of computing modules in Further Education to Higher Education. Currently, he is a HE Programme Leader for the BSc Hons Top-up degree.

Jodie Donovan is interested in BSc Games Technologist, STEM Ambassador, member of North East Women in Games, and consultant researcher for Newcastle College University Centre game jam. Their hobbies and interests include level design, horror, and cinematography.