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**Universitat Autònoma
de Barcelona**

MASTER'S DISSERTATION

Accessibility in PC Action/Adventure Games

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Abstract

According to the Convention on the Rights of People with Disabilities, Information and Communications Technologies (ICT) must be accessible. For this reason, the objective of this study was to discover the accessibility level of fifty PC action/adventure games released in the last twelve years (2010-2022). To this aim, a checklist of options and features following current guidelines (Game Accessibility Guidelines (GAG) and Xbox Guidelines), laws (Twenty-First Century Communications and Video Accessibility Act of 2010 from the United States), and standards (European EN 301 549) was created. The games were selected based on availability, iterations, and popularity. They were reviewed and played to verify if the accessibility features were available. An accessibility percentage was obtained by dividing the number of present GAG by the number of possible GAG applicable to each title. The results revealed that 44% of the titles follow guidelines, 81% include guidelines for people with cognitive disabilities, 44% for motor and speech disabilities, 38% for auditory, and 25% for visual. The examined games are not entirely accessible, but most comply with guidelines addressing the needs of people with cognitive disabilities and basic accessibility levels. Further research lines include multiplatform accessibility assessments from different genres, publishers, and studios.

Keywords: video games, accessibility, guidelines, disabilities, action/adventure, PC

Resumen

Según la Convención Internacional sobre los Derechos de las Personas con Discapacidad, las tecnologías de la información y las comunicaciones deben ser accesibles. Por ello, el objetivo del estudio fue descubrir el grado de accesibilidad de cincuenta juegos de acción/aventura para PC publicados en los últimos doce años (2010-2022). Para lograrlo, se creó una lista de comprobación de opciones y características conforme a las directrices para videojuegos, leyes y normas vigentes, como EN 301 549 en Europa. Los juegos se seleccionaron según la disponibilidad, franquicias con varios títulos y grado de popularidad. Cada título se evaluó para comprobar si se cumplían las directrices vigentes. Se obtuvo un porcentaje de accesibilidad al dividir el número de directrices disponibles entre las posibles y aplicables a cada título. Los resultados revelan que el 44% de los juegos siguen directrices, el 81% incluyen pautas para personas con discapacidades cognitivas, el 44% para las motoras y del habla, el 38% para las auditivas y el 25% para las visuales. Los juegos examinados no son totalmente accesibles, pero la mayoría cumple con directrices de accesibilidad cognitivas y niveles básicos de accesibilidad. Futuras vías de investigación incluyen evaluaciones de accesibilidad multiplataforma de diferentes géneros y estudios.

Palabras clave: videojuegos, accesibilidad, directrices, discapacidades, acción/aventura, PC

Resum

Segons la Convenció sobre els Drets de les Persones amb Discapacitat, les Tecnologies de la Informació i la Comunicació han de ser accessibles. Per això, l'objectiu de l'estudi és avaluar el grau d'accessibilitat de 50 jocs d'acció/aventura per a PC publicats en els últims 10 anys (2010-2022). Per aconseguir-ho, es va crear una llista de comprovació d'opcions d'accessibilitat en conformitat a les normes, lleis i recomanacions, com les directrius per a videojocs i l'estàndard EN 301 549. Els jocs es van seleccionar segons la disponibilitat, franquícies amb diversos títols i popularitat. Cada títol es va avaluar per comprovar si es complien les directrius. Es va calcular un percentatge a partir de la divisió del nombre de directrius d'accessibilitat presents entre les directrius possibles i aplicables. Els resultats revelen que el 44% dels jocs segueixen directrius d'accessibilitat, el 81% inclou directrius per a persones amb discapacitats cognitives, el 44% per a motores i de la parla, el 38% per a les auditives i el 25% per a les visuals. Els jocs examinats no són totalment accessibles, però la majoria compleix amb les directrius cognitives i els nivells bàsics d'accessibilitat. Futures vies d'investigació inclouen avaluacions d'accessibilitat multiplataforma de diferents gèneres i estudis.

Paraules clau: videojocs, accessibilitat, directrius, discapacitat, acció/aventura, PC

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Introduction

Video games, as an audiovisual product, have sounds, images, and mechanics that not everyone can see, hear, or execute, and the persons, who for any reason cannot, have the same right to enjoy, perceive, and interact with them as anyone else. Therefore, games launch with barriers that exclude gamers from playing them. For this reason, the researcher decided to conduct this investigation on the topic of accessibility in video games from the action/adventure genre on the personal computer platform (PC) to demonstrate what the status of accessibility currently is and has been in the last twelve years.

In accordance with the theoretical framework section of this work, authorities have enacted legislation on accessibility such as the Convention on the Rights of Persons with Disabilities (CRPD), the European Accessibility Act (EAA), the Harmonized European Standard (EN) 301 549, and the Twenty-First Century Communications and Video Accessibility Act of 2010 (CVAA). Moreover, industry experts and specialists from media outlets engaged in raising accessibility awareness have put their knowledge and experience together to form recommendations such as the Game Accessibility Guidelines and the Xbox Accessibility Guidelines. Due to these circumstances, analyzing accessibility directly in-game opens another view for researching accessibility, expands with factual evidence on the level of accessibility in a distinctive and innovative audiovisual product such as video games, and puts guidelines to use as evaluation instruments.

The purpose of this investigation is to demonstrate how accessible fifty PC action/adventure games are (see list of examined games in appendix 2). More specifically, as the results and discussion segment note, the main research question of this study is how accessible are PC action/adventure games according to the Game Accessibility Guidelines? Furthermore, this study also provides answers to the following questions: Are action/adventure games more accessible now? What accessibility features have developers stopped supporting and/or added and why? What are the most common accessibility features in PC action/adventure games? Have PC action/adventure games become more accessible since 2010? The main findings obtained from the investigation show that the action/adventure genre is not accessible now, and has not been since 2010, but the level of accessibility has been improving ever since. Releases from the past five years are more accessible than the titles released ten years ago. This paper shows to

what extent the assessed group of video games are accessible and elucidates areas of improvement for developers and publishers to hopefully help them concentrate their efforts in creating accessible worlds for everybody that, at the same time, are compliant with accessibility regulations enacted in the countries or regions where their product is sold. Lastly, the center of this work is inclusivity; therefore, efforts have been made to use inclusive language.

Theoretical Framework

The theoretical framework of this research follows three main subjects: the laws, standards, and guidelines that have been enacted around the world to make Information and Communications Technologies (ICT) accessible to everyone, the definition of the term “disability” and its types, and an overview of several video game accessibility guidelines. First, in terms of legislation, authorities across the globe have created regulations of foremost importance to promote accessibility. The spectrum of these policies is global with the United Nations Convention on the Rights of Persons with Disabilities (CRPD), regional, in the case of Europe, with the European Accessibility Act (EAA) and the Harmonized European Standard (EN) 301 549 (Accessibility requirements for ICT products and services), and national, in relation to the United States, with the Twenty-First Century Communications and Video Accessibility Act of 2010 (CVAA). Additionally, other countries such as Australia have enacted or endorsed their policies. The second topic is disability and its types (broken down into five), which includes an overview of some of the barriers that gamers face. The third and final topic covered in this review is video game accessibility. Leading companies such as Microsoft and Sony, developers, and experts from the video game industry have published accessibility guidelines and strive and show commitment to making their consoles, games, and services accessible to everyone. While Steam, created by Valve Software and the PC leading platform, is an example of low accessibility quality. Video games, as part of the cultural life and linked to Information and Communications Technology, must be accessible (in accordance with the CRPD); for this reason, the framework of this research outlines which existing laws and guidelines reinforce accessibility (organized by regions and scope of application), provides an overview of the concept of disability, and examines several accessibility recommendations designed by the industry to help game developers create accessible experiences for all.

With respect to legislation, several countries have passed treaties and laws to make ICT accessible: starting with the Convention on the Rights of Persons with Disabilities (ratified almost worldwide); at a European level, the European Accessibility Act and Accessibility requirements for ICT products and services, which European Member states transposed in their national laws; and lastly, other countries such as the United States have the CVAA. The United Nations Convention on the Rights of Persons with Disabilities is a treaty in which States Parties agree to “promote, protect and ensure the full and equal enjoyment of all human rights and

fundamental freedoms by all persons with disabilities” (4). Moreover, article 9 of this agreement is about accessibility. The Parties agreed to

enable persons with disabilities to live independently and participate fully in all aspects of life . . . ensure to persons with disabilities access, on an equal basis with others, to . . . information and communications technologies and systems . . . [including] identification and elimination of obstacles and barriers to accessibility, [that] shall apply to . . . Information, communications and other services, including electronic services and emergency services . . . [and] to promote the design, development, production and distribution of accessible information and communications technologies and systems at an early stage, so that these technologies and systems become accessible at minimum cost. (9-10)

Not only does this Convention ensure that persons with disabilities receive equal treatment, but also asserts that accessible design is a crucial aspect to make accessibility possible. In addition, article 30 affirms: “States Parties recognize the right of persons with disabilities to take part on an equal basis with others in cultural life” (22). Video games, as the main product of a market worth billions and played by millions of gamers, are a form of computer technology and part of the lives of many people and their cultures. Therefore, to meet the requirements of these articles, video games must be accessible.

As for Europe, another ruling aimed towards accessibility is the European Accessibility Act (EAA), which mirrors the obligation of this region to comply with the CRPD by promoting and improving access to mainstream products and services such as computer hardware, operative systems, terminals used for payment and communication, electronic readers, audiovisual media services, websites, and applications provided to consumers after June 28, 2025 (European Commission 70, 83-84). A second example from the European implementation of accessibility legislation is the European standard EN 301 549 developed by ETSI (European Telecommunications Standards Institute), CEN (European Committee for Standardization), and CENELEC (European Committee for Electrotechnical Standardization). This standard has been endorsed and transposed by most European countries, including Spain, and specifies the accessibility requirements for ICT products and services from the point of view of functional performance by helping the user locate, identify, operate, and access functions and information

(ETSI et al. 20). For users with visual disabilities, the requirements for products and services include menu narration; screen reading; audio description; screen magnification; contrast, brightness, and intensity controls; and colorblind modes and filters. In the auditory subgroup, the standard sets sign language and subtitle guidelines and enhanced audio features (such as reduction of background noise and monoaural options). For users with speech disabilities, the requirement is a mode of operation without orally generated sounds. In the same manner, usage with motor disabilities (without manipulation or with limited strength and reach) requires the product or service to provide alternative actions. For cognitive needs, products or services must be simple to understand and easy to follow, operate, and use, and need to have adjustable timings, error indications, spelling aid, and word prediction. Moreover, this standard also extends to providing one mode of operation that minimizes photosensitive seizure triggers (20). In comparison, EN 301 549 presents more concrete guidelines than the general provisions of the EAA and elaborates on how the European Union is set to comply with the CRPD that its member States ratified.

Similarly, other countries have also enacted their accessibility laws. For example, in the United States, the CVAA intends to “increase the access of persons with disabilities to modern communications” (United States, Congress 1) and makes accessibility a requirement in communication services found in game software, gameplay, and consoles (IGDA-GASIG). Video games rely on communications systems because people communicate in-game. For instance, gamers talk to each other via in-game text or voice chat or using third-party applications (e.g., Discord) when playing together over the internet in multiplayer games. Therefore, as accessibility specialist Ian Hamilton notes, a game with voice or text chat and any “[user interface] or information needed to navigate and operate the communication functionality” falls under CVAA because this Act is mainly aimed at communication and “does not require accessibility of gameplay in general . . .” (“Demystifying CVAA”). Moreover, the CVAA outlines that these communications must be operable with low vision, no vision or hearing, little or no color reception, limited reach, strength, manual dexterity, without speech, and limited cognitive skills (“Demystifying CVAA”). While accessible game design is not part of the CVAA, every game menu that players with disabilities must navigate to reach and control communication features in any game sold in the United States must take accessibility into account (Johnson) and provide modes that do not require vision, hearing, speech, motor, and

advanced cognitive capabilities to communicate. Other country-specific examples of accessibility legislation include the adoption in 2016 of EN 301 549 in Australia (“AS EN 301 549:2020”; “Australian Policy”), and the United Kingdom Equality Act 2010 (“Equality Act 2010”) that enacted accessibility strategies for people with disabilities. In conclusion, the magnitude of accessibility legislation is global, regional, and national as regulation examples from Europe, the United States, or Australia aim to make ICT accessible to everyone.

The second essential part of this framework is based on outlining the concept of disability and its types and pointing out obstacles imposed by not correctly contemplating accessibility guidelines in ICT. The United Nations CRPD outlines that “disability is an evolving concept and that disability results from the interaction between persons with impairments and attitudinal and environmental barriers that hinders their full and effective participation in society on an equal basis with others” (1). Furthermore, the Merriam-Webster dictionary defines disability as “a physical, mental, cognitive, or developmental condition that impairs, interferes, or limits [the ability to take part] in typical daily activities and interactions” (“Disability, N (1)”). In addition, according to the World Health Organization, 1 billion people have a disability around the world (“Disability and Health”), of which 400 million play video games (Mortaloni), 135 million are in Europe (“Disability”), and 61 million live in the United States (“Disability Impacts All of Us”). These numbers translate into a sizable portion of video game players missing the full experience that a game is designed to provide. Nevertheless, gamers with disabilities rely on options and accessibility features being baked into games and designed with a specific circumstance in mind. To conclude, disability is a physical, mental, cognitive, or developmental condition that, when playing video games, impairs and hinders equal access to information and technology not intended to be accessible.

Regarding types of disabilities, the W3C Web Accessibility Initiative, on their web resource titled “Diverse Abilities and Barriers,” shares detailed classifications and identifies barriers from the point of view of web accessibility that can also apply to video games. Moreover, Ellis and colleagues limit their Game Accessibility Guidelines to five subcategories because of how they relate to types of skill and disability when playing an electronic game: auditory, cognitive, physical (motor), speech, and visual (“Why”).

In the auditory subdivision, disabilities range from “hard of hearing” to “deafness.” An individual with these disabilities could face barriers with audio content unless the game comes with subtitles. Others may need to toggle a mono option to hear from one ear only, or require to individually control the volume of music, dialogue, and sound effects. Cognitive disabilities include learning and neurological conditions and seizure, behavioral, or mental disorders. These may affect how “people hear, move, see, speak, and understand information” (Abou-Zahra). Some obstacles are intricate game mechanics, words, text, and the lack of an option to reduce or suppress sensitive content entirely (flashing lights, distressing images, sounds, or themes). Physical impediments limit control of body movements; for example, arthritis, the loss of a limb, fibromyalgia, rheumatism, reduced dexterity, muscular dystrophy, tremors, spasms, and partial or total paralysis (Abou-Zahra). Among the barriers, gamers with these conditions face problems when the game requires quick reactions, is overly fast for them, is incompatible with other input devices, or lacks customization of controller options to make controls function according to their needs (e.g., playing the game one-handed or lefty). The fourth type of disability is speech and “include[s] difficulty producing speech that is recognizable by others or by voice recognition software” (Abou-Zahra). Gamers with speech limitations cannot participate equally with other players in games controlled exclusively via voice commands or use voice chat as the only means of communication.

Lastly, visual disabilities involve low vision, blindness, and lack of sensitivity to colors (colorblindness) (Abou-Zahra). This means that a certain degree of textual information in subtitles or in the game menu, images, and orientation signals will not be fully available to these players. This categorization draws a parallel with the disability groupings found in EN 301 549, the CVAA, and the Game Accessibility Guidelines. To summarize, experts on accessibility separate disabilities into five types with each involving a combination of hurdles.

The last fundamental part of the theory of this research is an overview of video game accessibility guidelines. Not all companies in the video game industry are deeply embedded and committed to creating accessible worlds and adventures in their games. However, some have created game accessibility guidelines to ensure and help accessible design become an industry standard. Accessibility is the key to fixing the obstacles created by an unconscious game industry. Moreover, many game makers work in countries legally required to comply with the

legislation explored in this review. Due to these reasons, businesses at the forefront of the industry, such as Microsoft and Sony, have made their commitment public by launching their guidelines and making their products and services more accessible.

To make video games “easily used or accessed by people with disabilities” (“Accessibility, Adj. (5)”), Microsoft, with the Xbox brand, launched the Xbox Accessibility Guidelines (XAG), which “are a set of best practices that have been developed in partnership with industry experts and members of the Gaming & Disability Community” (“Xbox Accessibility Guidelines”). Currently, the guidelines consist of 23 recommendations that can be grouped and are applicable between the five types of disabilities previously discussed in this framework: visual, hearing, cognitive, motor, and speech. Beginning with the visual considerations, game developers should implement audio description, good readability in texts, contrast, screen narration, conveyance of visual cues through other means, haptic feedback (while useful for people with visual or auditory disabilities, this function could be bothersome for players with sensitive hand muscles), and have accessible and customizable user interfaces. Among the guidelines for players with deafness or who are hard of hearing, games should express audio prompts through other methods and should have subtitles, captions, separate volume controls, and speech-to-text for communication with other players. As part of the cognitive measures, game designers should care about game difficulty options, clarity of objectives (to avoid gamers getting lost or to remind or indicate where the next objective is), error messages and destructive actions (to avoid in-game actions to take place due to accidental button activations such as erasing game or save data), and systems to help reduce health conditions caused by photosensitivity. For motor disabilities, Xbox guidelines suggest compatibility with other modes of operation and adequate time limits (valuable for players that need more time to interact or as a cognitive adaptation to read and interpret information). Lastly, games should have features for players with speech difficulties such as letting them control the game not only with speech and providing text-to-speech chat to ensure that they can communicate in online games. The guidelines encourage developers to be creative and to go beyond the minimum. They conclude with other practical recommendations not related to a disability; for instance, availability of documentation about accessible features that players can consult before buying a game and accessible customer support. To summarize, Xbox is pushing accessibility forward with the help of its recommendations for accessible game design.

Another example of how the Xbox brand ensures accessibility in their space is with a new feature for Xbox games called Accessibility Tags, where “games in the Microsoft Store can now display tags that indicate specific accessibility features, making it easier for players to find the titles that meet their needs and interests” (“Accessibility features on Xbox games”) to help gamers “make informed decisions before [they] buy or download” (Mortaloni). The implementation of these tags is a welcome addition because players can avoid returning or putting their newly purchased games away after realizing they cannot play them. Microsoft also created the Microsoft Gaming Accessibility Testing Service (MGATS) as an optional testing system to ensure that titles are accessible (“Microsoft Gaming Accessibility Testing Service”). In addition to the Xbox guidelines, the tags, and the MGATS, the American company also designed the Xbox adaptive controller for gamers with limited mobility because “when everyone plays, we all win” (“Xbox Adaptive Controller”). As a prominent company, Microsoft with the Xbox is breaking the boundaries of accessibility and innovating by attaching accessibility tags to the games in their store, creating an accessible game controller, and inviting other developers to be accessible with their testing service.

Microsoft is not alone in this endeavor for accessibility because Sony is doing its corresponding part with the PlayStation Store, the PlayStation 5 (PS5) console, and the games that they publish. The Japanese company even rebranded the PlayStation identity with their newest slogan: “Play Has No Limits” (Lempel). Although the store is missing important information on accessibility features, even on the games they claim to be accessible (as to help gamers before they buy), currently, the PS5 comes with a host of accessibility options and functions, namely text size, bold text, zoom, contrast, colors, motion, screen reader, closed captions, custom button assignment, and vibration intensity (“Accessibility Features on PS5 and PS4”). These settings benefit gamers who need visual, auditory, and motor aids to use the console, participate, and enjoy equally with everyone in the PlayStation system. With regards to games, Sony published *The Last of Us Part II*, dubbed by news outlets as one of the most accessible games of all time with over sixty accessibility features (Gallant; Molloy and Carter). Sony will also publish *God of War Ragnarök*, a title recently announced to have more than sixty accessibility options that would potentially place the game on par with *The Last of Us Part II* in terms of accessibility (Pavlin). As an influential company in the gaming medium, Sony is leading by example with the accessibility features of the PlayStation 5; notwithstanding, they can

improve the digital store to extend their accessibility reach separately from the console and their games and add the same features and more (such as accessibility tags) to this website.

Nevertheless, not all gaming enterprises have implemented accessibility standards as Microsoft and Sony. Steam, a video game digital distribution service developed by Valve, needs to include more basic accessibility options into their store and client. According to the article “Steam: An Accessibility Nightmare,” the “accessibility of Steam is broken” because both the website and the Windows client have low contrast texts, screen reader incompatibility issues, and difficult input device support for keyboard-only navigation. The absence of accessibility options makes using Steam and buying games more complicated for users with disabilities; however, this view overlooks the fact that the Steam client breaks barriers with its remote play and text and voice chat functions. Also, the PC application is compatible with many controllers and allows users to change a wide range of controller configuration options, and big picture mode has a large font size, simple navigation, and an on-screen keyboard. The digital distribution services of Valve have room for improvement; however, Steam is accessible to a limited degree.

Moving away from what specific companies are doing in terms of accessibility, several studios, specialists, and academics have composed the Game Accessibility Guidelines (GAG) to “produce a straightforward developer friendly reference for ways to avoid unnecessarily excluding players, and ensure that games are just as fun for as wide a range of people as possible” (Ellis et al., “Game Accessibility Guidelines”). The GAG are grouped into six types that relate to the ability required to play a game (auditory, motor, cognitive, visual, speech, and general). Ellis and colleagues divide the guidelines even further into three levels: basic (recommendations that are easy to implement), intermediate (ideas that require more effort but are worthwhile), and advanced (suggestions that imply complex adaptations). Furthermore, the authors devised over a hundred comprehensive principles, and they provide examples on how to implement accessibility for visual, auditory, motor, cognitive, and speech disabilities. As article 9 of the CRPD points out, game makers and publishers can avoid retrofitting costs and make access to this technology and the information within available at a lower cost to more people who live with a disability by considering accessible design from the preliminary stages of development (9). The guidelines reviewed in this paragraph are not only meant for persons with disabilities. Their usefulness goes beyond and extends to other situations; for instance, to help a

player who does not know how to read (children), or someone who cannot play with sound on, or who is far from the screen to be able to read or needs to turn off flashing lights to avoid experiencing a migraine episode. Also, these guidelines coincide with regulations found in EN 301 549 or the CVAA. In essence, the GAG are a set of recommendations that range from basic to advanced execution levels and are freely available to developers and publishers; additionally, the gaming industry can use these principles as guide in the creation of games that not only comply with national laws, but that anyone can play.

To summarize, with the ratification of the CRPD, countries and regions around the world have committed to making ICT accessible to all by passing treaties and laws such as the EAA and the CVAA; in addition, in the gaming medium, disabilities can be divided into five main types (visual, auditory, cognitive, physical, and speech) that when not considered, create accessibility hurdles; and lastly, the game industry has designed guidelines to improve the level of accessibility in video games. Furthermore, the evidence to improve accessibility in video games is clear. The ratification of the CRPD has had far-reaching consequences such as the creation of national laws that recognize the rights that persons with disabilities have toward playing a video game. This enables them to be a part of the community and connect with other players. The available video game guidelines are an inside reflection of an industry willing to encourage accessible game design and ready to comply with accessibility legislation in various parts of the globe. These best practices, along with accessibility testing services (MGATS, for example), guide game designers and important decision-makers on how to create games that do not exclude players with disabilities. The literature reviewed herein manifests a predominance of mindfulness towards including accessibility options and mechanisms in video games. In conclusion, the legislation on accessibility is international and robust; moreover, theory on gaming with disabilities indicates that these can be categorized depending on the needs of the user; and finally, video game companies are focused on accessibility because console makers, publishers, developers, and experts have designed guidelines to help the industry steer toward accessibility and address their responsibility to make accessible and inclusive games.

Methodology

The methodology followed to conduct this study consisted in the creation of a checklist of accessibility options and features following existing video game accessibility guidelines, and current accessibility laws such as the CVAA and standards such as the EN 301 549. The checklist was used to analyze and inspect the accessibility level of a sample of video games selected for this study, which consists of fifty action/adventure games launched on the PC platform from January 2010 to April 2022. The selection criteria of the games was based on availability (titles that the researcher had access to), iterations (the number of games from the same franchise released in the timeframe), and popularity (for example, PlayStation exclusive games released for PC). The checklist is divided in seven main parts: descriptive metadata about each game, general, auditory, visual, motor, cognitive, and speech. This instrument was created from a comparison between the Accessible Games Database (a web resource with search filters created by DAGERSystem to help users search for accessibility features in games), the recommendations found in the Game Accessibility Guidelines, the requirements of the Harmonized European Standard EN 301 549, and the suggestions provided in the Xbox accessibility guidelines.

Each inquiry about game accessibility features was designed to elicit one response (pass, fail, or not applicable). In addition, a color was assigned to some options and features in relation to how much work, planning, and adaptation the accessibility element requires. The options selected for this research are settings that the player can change, adjust, customize, or choose to use (the user has control over); while the features are characteristics that the player cannot change, adjust, customize, or choose to use (not player-controlled), and are related to how the game was designed. These options and features are intertwined and altogether make up the accessibility suite of a video game. Moreover, some options were assigned a color according to the GAG degree of complexity of the feature: basic, intermediate, and advanced (Ellis et al., “Why”). For instance, adding subtitles to a game is a basic standard, but providing subtitles for the deaf and hard of hearing is intermediate, and incorporating audio description is an advanced feature (Ellis et al., “Excel”). The assigned colors for the different levels are green for basic, blue for intermediate, and orange for advanced. Color coding allows to identify if the accessibility options employed in games are at basic, medium, or advanced levels.

This document also incorporates metadata of each game. The descriptive metadata consist of three pieces of information related to each video game: franchise to which the title belongs to, release year, and available languages. Game metadata has been collected to check if accessibility options correlate to other game details (e.g., to compare accessibility by release year or franchise). The general section includes options and features that are useful for every user: how the game saves player progress, if the game has a dedicated accessibility menu, if the player can pause gameplay, aim assist, drive and shoot aim assist, and difficulty options (preset difficulty, difficulty is adjustable at any time, bypass gameplay, custom options, and adaptive difficulty).

The next five sections are related to the main types of disabilities. The settings in these units were identified and grouped by disability category (i.e., auditory, visual, motor, cognitive, and speech) after comparing the Accessible Game Database filtering options (“Accessible Games Database”), the requirements of EN 301 549, the Xbox recommendations, and the Game Accessibility Guidelines. The auditory accessibility options and features are volume controls, stereo/monaural toggle, subtitles, and speech-to-text (figure 1). In the visual aspect, the options

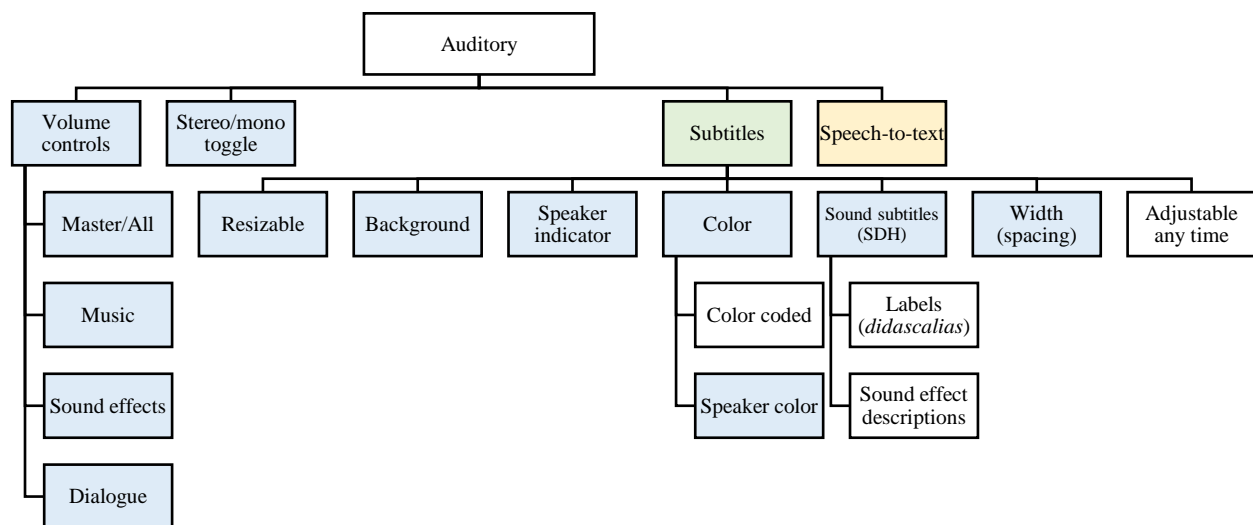


Figure 1. Auditory accessibility options and features.

and features are audio description, image adjustments, adjustable interface text, screen narrator

availability, screen magnification, toggles for camera shakes and screen flashes, surround sound,

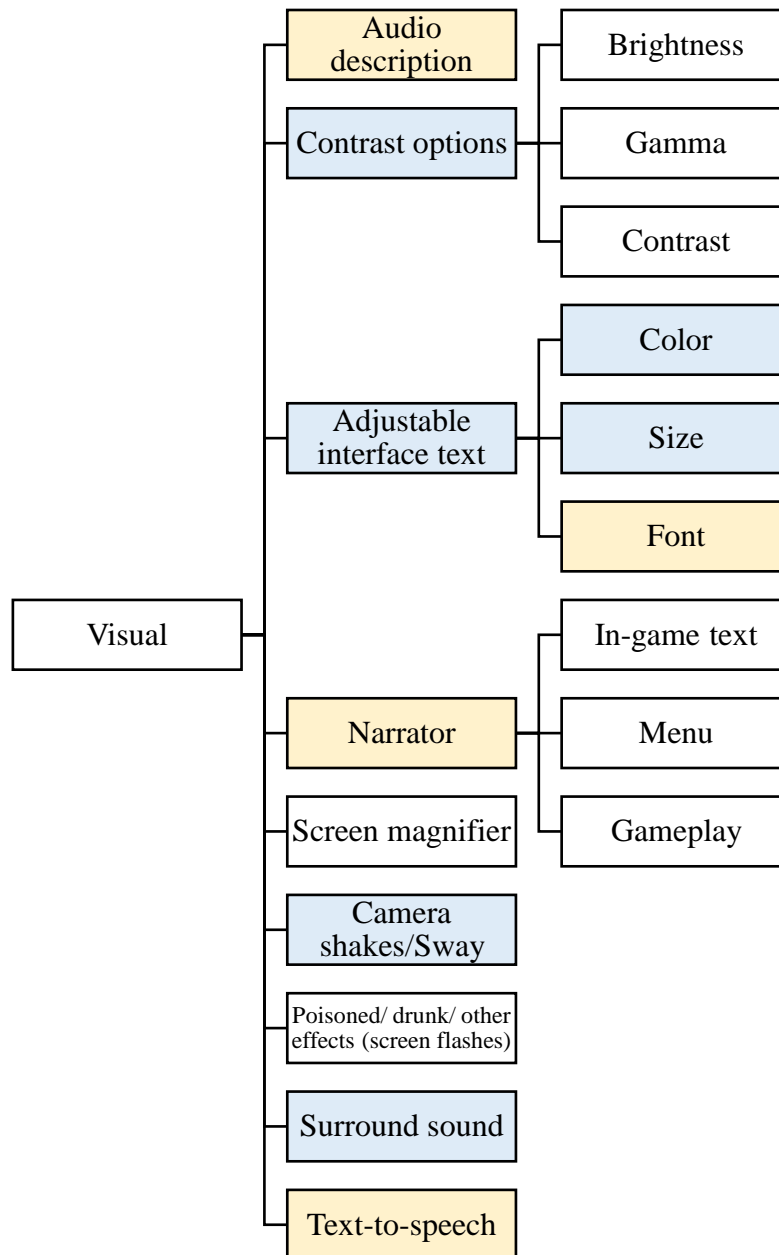


Figure 2. Visual accessibility options and features.

and text-to-speech (figure 2). Color options are also included in this category such as color customization of the heads-up display (HUD) and the implementation of a colorblind mode and filters for several types of colorblindness (figure 3). The options for gamers with motor disabilities include allowing the user to change repeated taps for holds or a single tap and change holds to presses, how quick-time events (QTE) are solved, vibration (rumble) toggle, and support

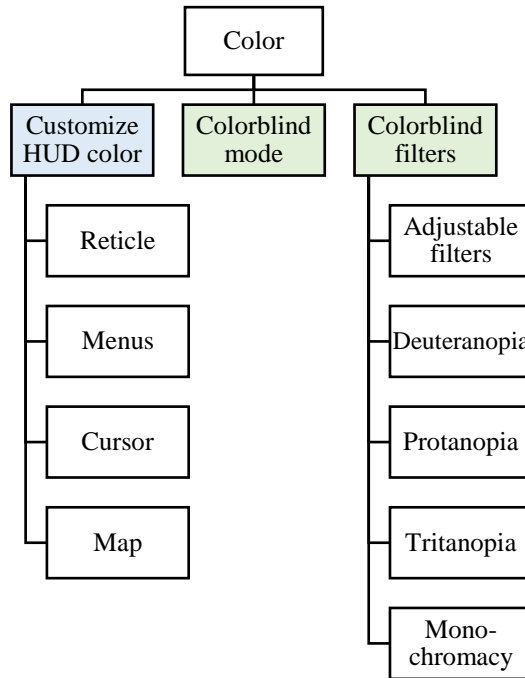


Figure 3. Color options.

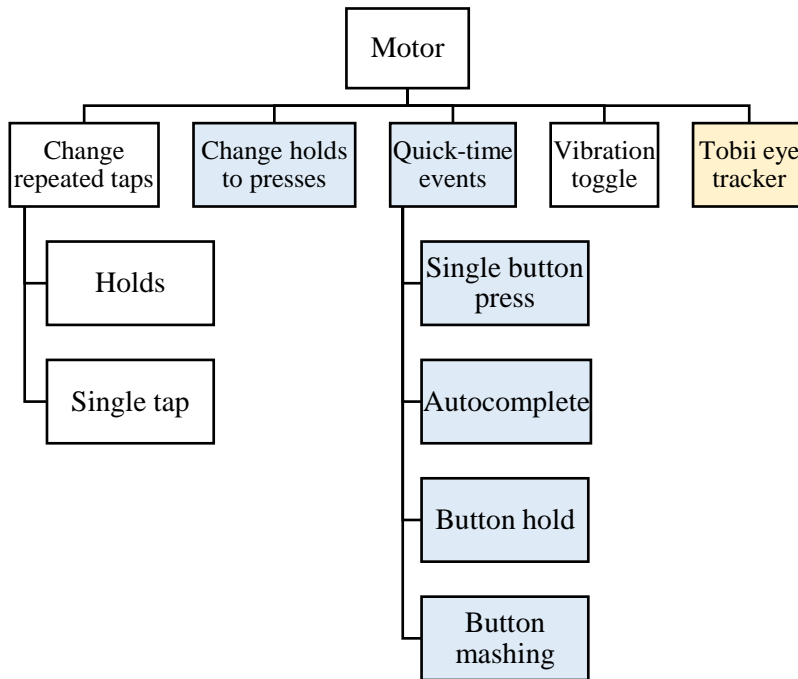


Figure 4. Options for motor disabilities.

for the Tobii eye tracker (figure 4). This category also includes control options and features. The options are controller customization (either full or partial), keyboard and mouse rebinding, simple controls or easier control alternatives, game speed, windowed mode, and availability of a

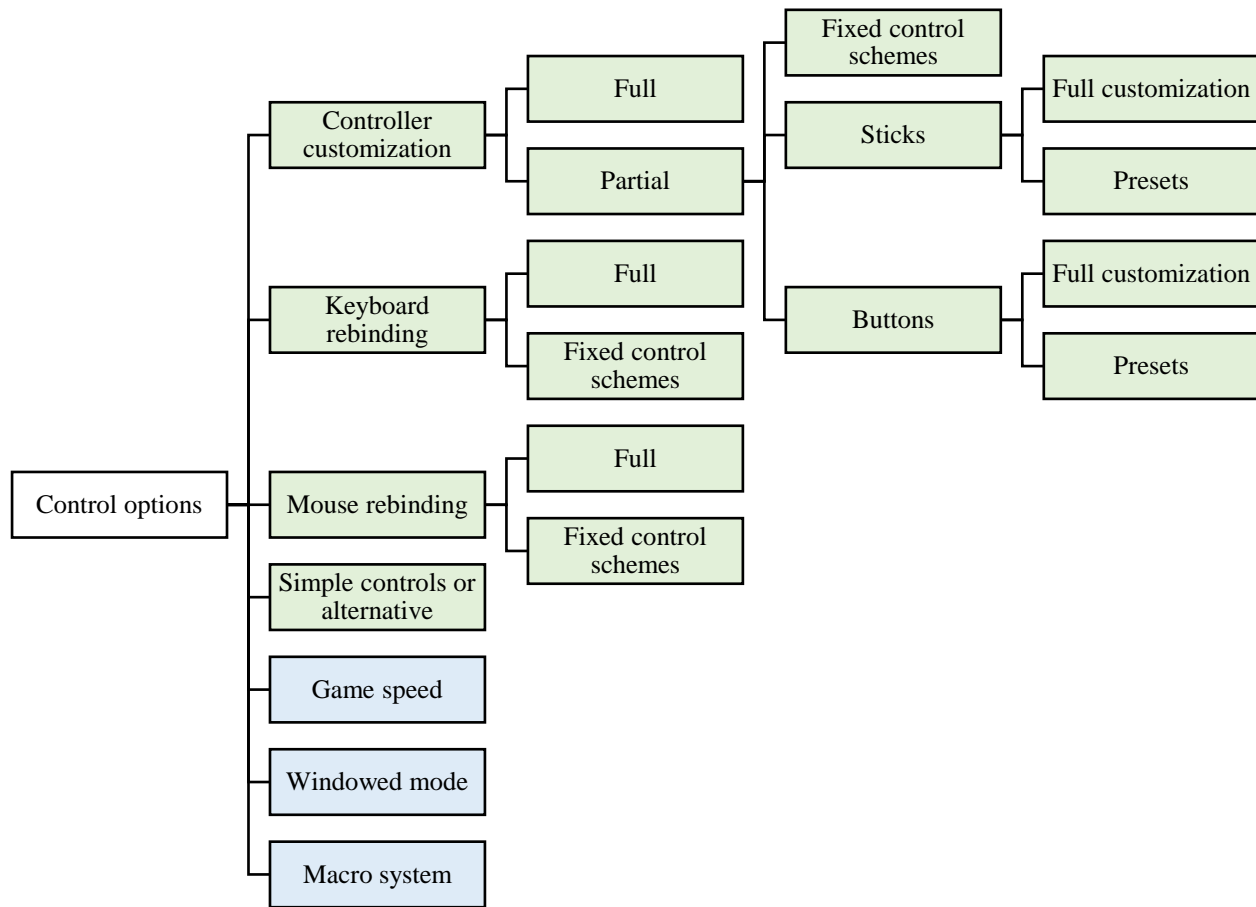


Figure 5. Control options.

macro system to help with repeated inputs (keyboard shortcuts, see figure 5). As part of the motor features, this research examined if the user interface areas are accessible using the same input as the gameplay, if the game supports more than one input device, if the user can set a post acceptance delay between inputs, and if the game allows the user to circumvent precise timing with alternative actions or a skip mechanism (figure 6). In the cognitive area, this research explored nine characteristics and options: accessibility chat (a visual communication method for multiplayer games), whether blood and gore can be turned off, presence of contextual in-game help and tips, reminders of gameplay objectives and controls, tutorials, and if the game can be started without going through multiple levels of menus (figure 7). Lastly, three aspects were analyzed for speech disabilities: if the game requires speech input, if players can choose to play online only with others who have voice chat enabled or disabled, and if the multiplayer

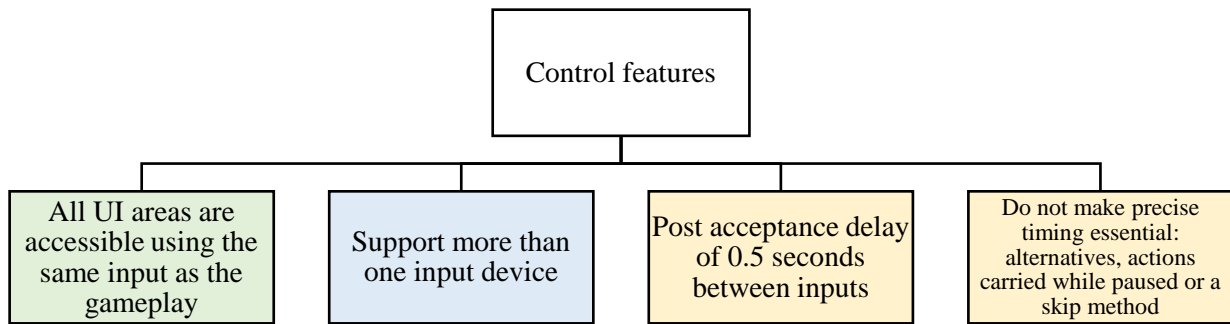


Figure 6. Control features.

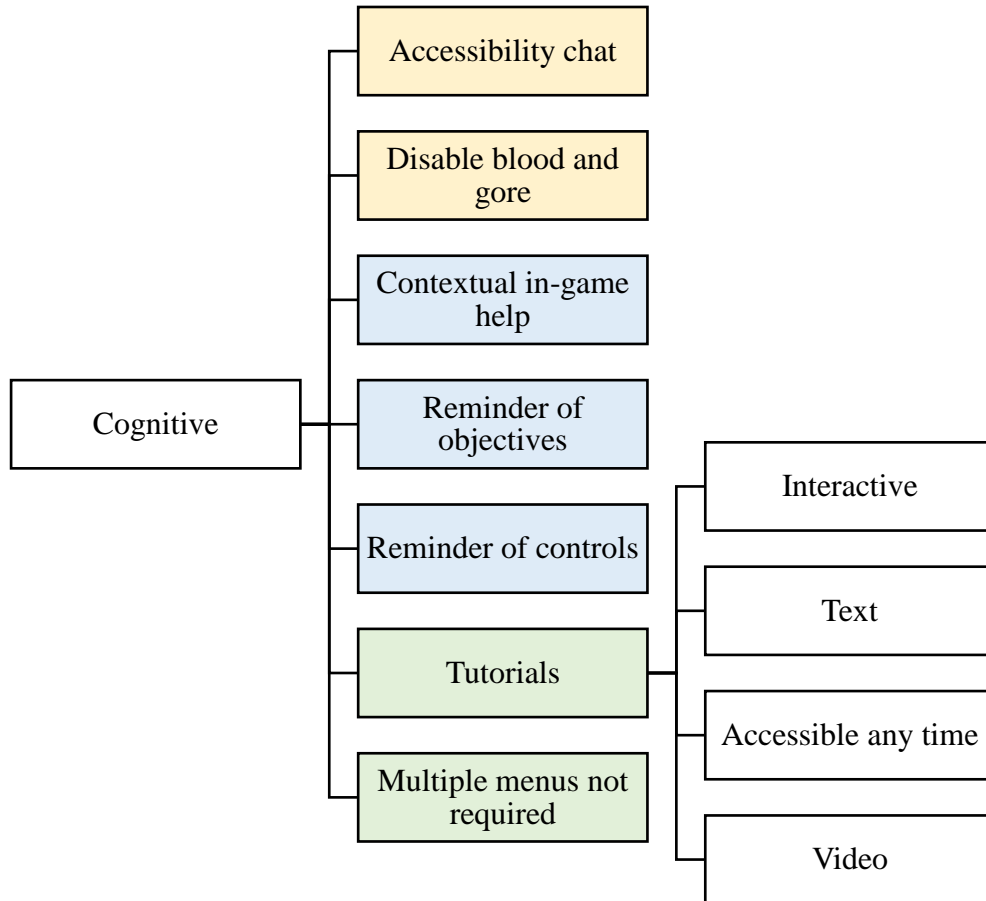


Figure 7. Cognitive options and features.

component of the game supports text or voice chat (figure 8). In this regard, several options are interconnected and useful not only for one type of disability; for example, the “game speed”

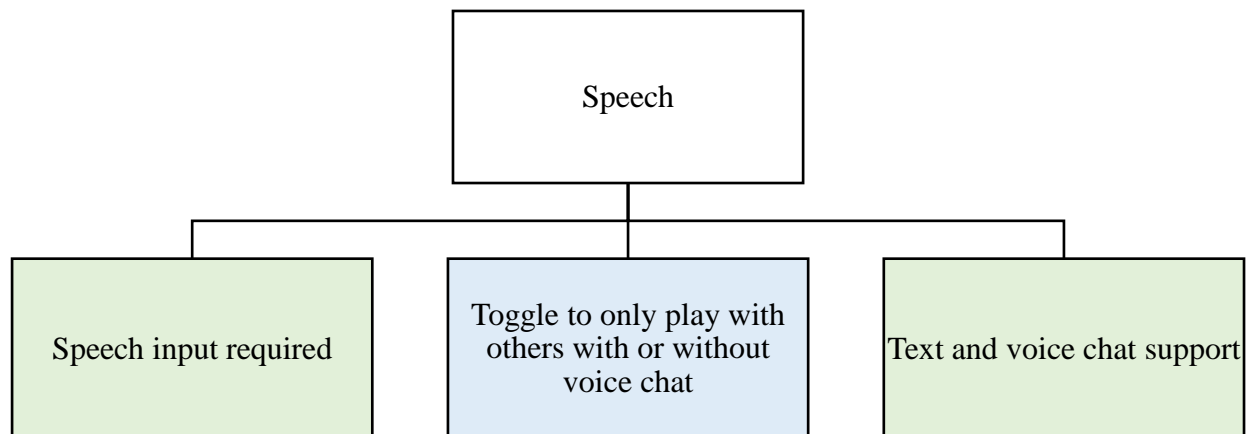


Figure 8. Options for speech disabilities.

option that allows a player to slow down the game engine is helpful for players who require cognitive and motor adaptations because they need more time to react, move, or process information from the game. Even if accessibility options and features have been grouped under one disability category, the benefits to other groups of gamers with disabilities have also been considered.

The study required an extensive examination of each selected game. To conduct the analysis, each title was booted on a personal computer where the game menus and gameplay were examined. This procedure helped to determine if an accessibility feature is present or absent in each of the games. The information obtained was cross checked with the PCGamingWiki entries of each game (PCGamingWiki) to confirm that the answers are correct. Data was entered in the checklist which was created using Microsoft Excel and Google Forms to simplify the data gathering process. After the data collection step was completed, the information was exported from both platforms for analysis and representation.

To determine the level of accessibility, a percentage was obtained by dividing the amount of Game Accessibility Guidelines present in a game by the number of possible guidelines that apply specifically to that title. Also, all accessibility features were assigned the same value. For example, fifty GAG apply to the game *Assassin's Creed Valhalla* and the number of guidelines actually present is forty. Therefore, if the amount of guidelines present is divided by the number of possible applicable guidelines, the percentage of guidelines present in that game (or an

accessibility level) would be 80% ($40/50 = 80$, see figure 9). The application of this formula can also help to extrapolate accessibility trends by year.

$$\frac{\text{Present guidelines}}{\text{Applicable guidelines}} = \text{Accessibility level}$$

Figure 9. Level of accessibility formula.

To summarize, the level of accessibility in the action/adventure games selected for this research was assessed with a comprehensive checklist of accessibility options and features. This instrument is the result of a combination of the accessibility requirements and recommendations found in EN 301 549, the Xbox guidelines, the Game Accessibility Guidelines, and the DAGERSystem Accessible Game Database. The design of this document ensures the inclusion of every accessibility-related option and feature relevant for the study in the form of data on accessibility options from fifty PC game titles from the action/adventure genre.

Results and Discussion

General

The first category presented in this section is general accessibility options and features. Starting with the method to save player progress, the investigation revealed that out of 50 games, 42 (84%) have an autosave feature (figure 10). The popularity of this feature is positive for accessibility because users do not have to worry about losing progress if they forget to save. Also, this eliminates the need to go through a checkpoint or visit a “place” in-game to save progress (for example, in the early Grand Theft Auto (GTA) titles, the player could only save at the house or apartment of the character). However, only 16 games (32%) have manual save, an accessibility option that allows the user to save the game at any time. Manual saving gives power to the player by letting them decide when to stop playing and not the other way around, where the game dictates when the player can save and (more freedom to the user). As the Game

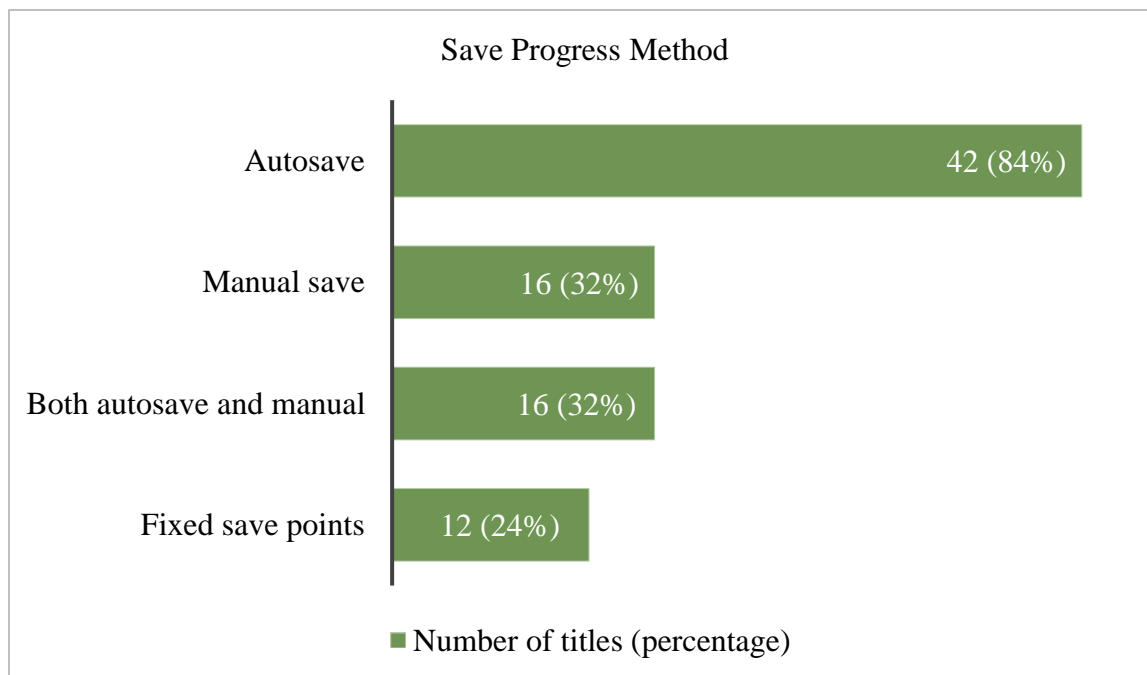


Figure 10. Results of the methods used by game developers to save user progress.

Accessibility Guidelines point out (Ellis et al., “Provide a manual save”), the ideal situation is to provide both manual save and autosave, which according to the investigation, only 32% of the releases do. Furthermore, the minimal use of fixed save points (also known as checkpoints and a method only implemented in 24% of the examined games) means that the open world nature of action/adventure games is more suited towards autosave rather than relying on a specific place to

save progress. In addition, fixed save points could be a feature in deprecation due to newer game engines supporting autosave and manual save in open world games. Overall, most game designers are implementing autosave, but they should improve in incorporating manual save more because the lack thereof is an unnecessary obstacle and hinders accessibility.

Another general accessibility feature is the presence of a dedicated accessibility menu (see definition in appendix 1). According to the results (figure 11), a vast majority of titles (41 out of 50) do not have a dedicated accessibility menu, but at least 9 titles do (18%), and 3 (6%) allow making accessibility adjustments when the player boots the game for the first time. Although not a requirement (this guideline is not part of the GAG or the XAG), because accessibility features and options are located on other subsections of the settings such as in the sound, display, or controls submenus, a dedicated menu is a welcome addition because the user can find the options easily in one place. Developers can also improve this feature even further by subdividing the accessibility menu by disability categories.

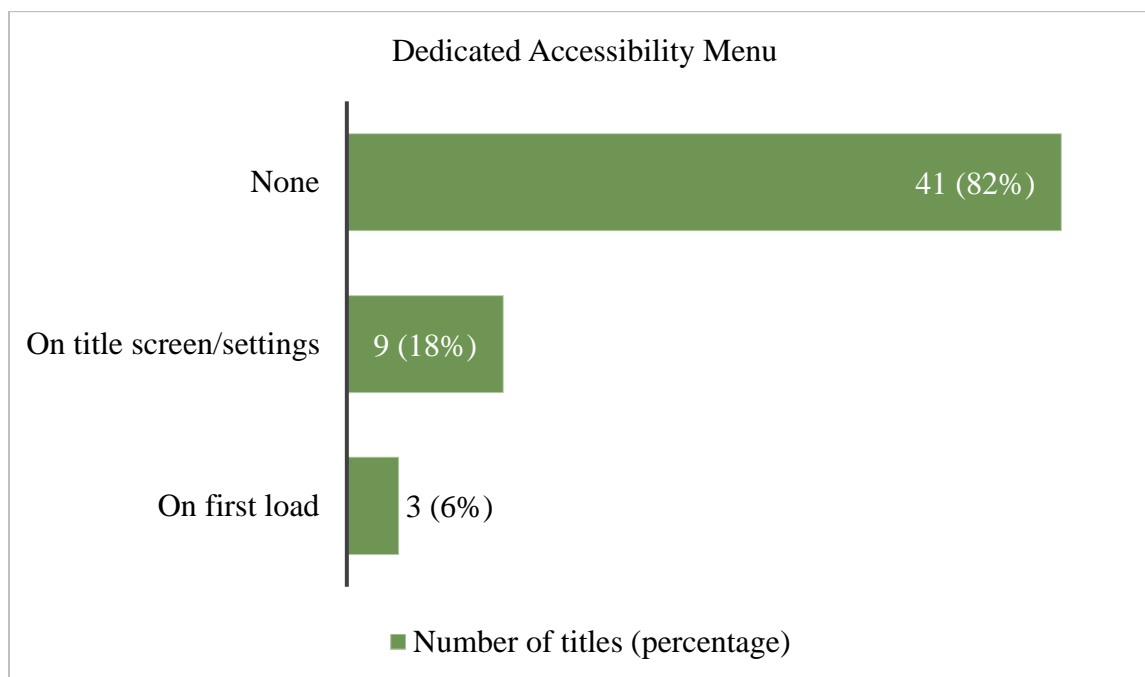


Figure 11. Results of games that have a dedicated accessibility menu.

Another studied general feature is the ability to pause gameplay. This is another aspect that gives the user more freedom and control of the game. Pausing is a frequent practice in single player games, but in online multiplayer video games, this feature changes as those titles do not

have a pause option due to the nature of the online environment and real-time interactions with other players. An example of this adaptive quality of pausing a game is present in *Dying Light*. The user can pause gameplay while in single player, but if the player joins a cooperative session, they cannot pause the game world unless all players pause the game as well. In this research, the ability to pause the game was tested in the single player component of the games and the results show that every one of these releases has a pause feature (100%). This means that single player action/adventure releases tend to allow the use of this option to pause for a break, which is great for accessibility; however, not all games from this genre were included in this research, and this feature should not be expected to come in every single player title, such as *Elden Ring* or the *Dark Souls* series by FromSoftware, where the user cannot pause even when playing offline. Notwithstanding, players can seemingly pause the majority of games, and this is a win for accessibility.

Aim assist (see definition in appendix 1) is another accessibility option included in this research. In action/adventure games, players fight enemies with weapons that require aiming. According to the results, a considerable percentage of the game sample with an aim mechanic has an assist feature for aiming (80% or 36 titles, see figure 12), where the aim snaps automatically to a target. However, this number decreases when the player can shoot while driving a vehicle (or riding a horse). The percentage of games with aim assist while driving is lower (57%), and therefore, present in more than half of the examined titles. Aim assist is an intermediate recommendation from the GAG that improves accessibility, and in this regard, action/adventure games seem to not have major difficulties with its implementation.

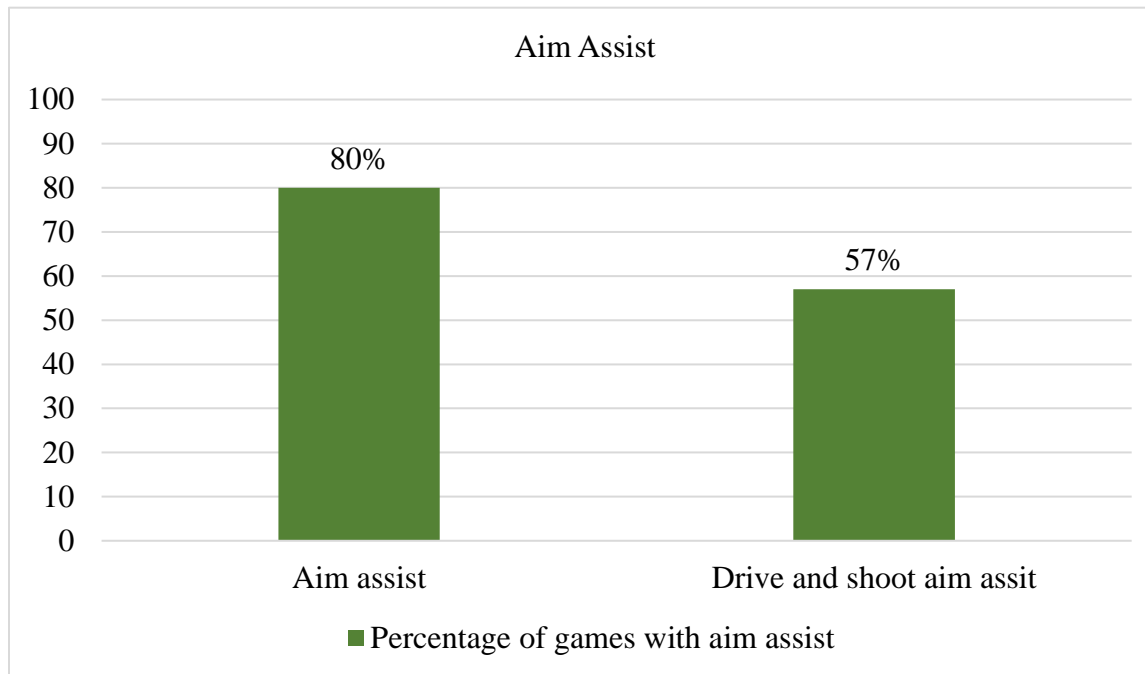


Figure 12. The percentage out of 45 games with aiming and 21 with a drive and shoot mechanic that implement aim assistance.

The last analyzed general accessibility options are related to game difficulty (figure 13). One of the positive findings is that a larger part of the games (72%) has predefined difficulty levels (see preset difficulty in appendix 1); therefore, most titles comply with this basic feature. Another positive result related to accessible difficulty settings is the fact that only 22% of the games lack a difficulty option. The majority of the titles of this investigation that come without difficulty options belong to the Assassin's Creed (AC) franchise and launched between 2010 and 2015. However, the franchise has improved on this limitation after 2017 with the releases of AC Origins, Odyssey (2018) and Valhalla (2020). These last three AC games allow players to change the difficulty mid-game. Nevertheless, and another area of improvement regarding difficulty, the ability to adjust difficulty at any time is a roughly popular feature present in 56% of the sample. Game makers should add this option more often because players have to start a new game (and lose progress) to be able to play in a different difficulty setting. A game that does not have this feature "punishes" players by taking their time, effort, and progress away in exchange of changing the difficulty.

Another guideline that needs more support is the ability to bypass or simplify gameplay (see definition in appendix 1). The number of games that allow the player to do this is minimal

(only 16% or 8 titles, see figure 13). Excellent examples of this implementation are in God of War (released in January, 2022 for PC) by Santa Monica Studio (the player can choose to simplify a game mechanic related to opening locked doors), in Grand Theft Auto V (2015) and Red Dead Redemption 2 (2019) by Rockstar Games (these games allow players to bypass mission checkpoints after failing constantly), and in Watch Dogs Legion (2020), AC Valhalla (2020), or Immortals Fenyx Rising (2020) by Ubisoft (the player can activate an option to simplify puzzles). Another accessibility guideline that the game sample does not broadly comply with is allowing the user to customize the difficulty (see custom difficulty in appendix 1). Out of 50 releases, only 5 (or 10%) allow the user to customize difficulty. These games are Shadow of the Tomb Raider: Definitive Edition (2018), AC Odyssey (2018), Tom Clancy's Ghost Recon Breakpoint (2019), AC Valhalla (2020), and Lego Star Wars: The Skywalker Saga (2022). In these releases, users can adjust difficulty settings separately by combat, exploration, and puzzle levels. Lastly, adaptive difficulty is an option that none of the examined games have. This setting adjusts difficulty automatically based on player performance. This is a feature that game makers should develop to make their games more accessible. To conclude, the difficulty options present in the majority of titles are basic and developers should add more intermediate difficulty features to improve their level of accessibility.

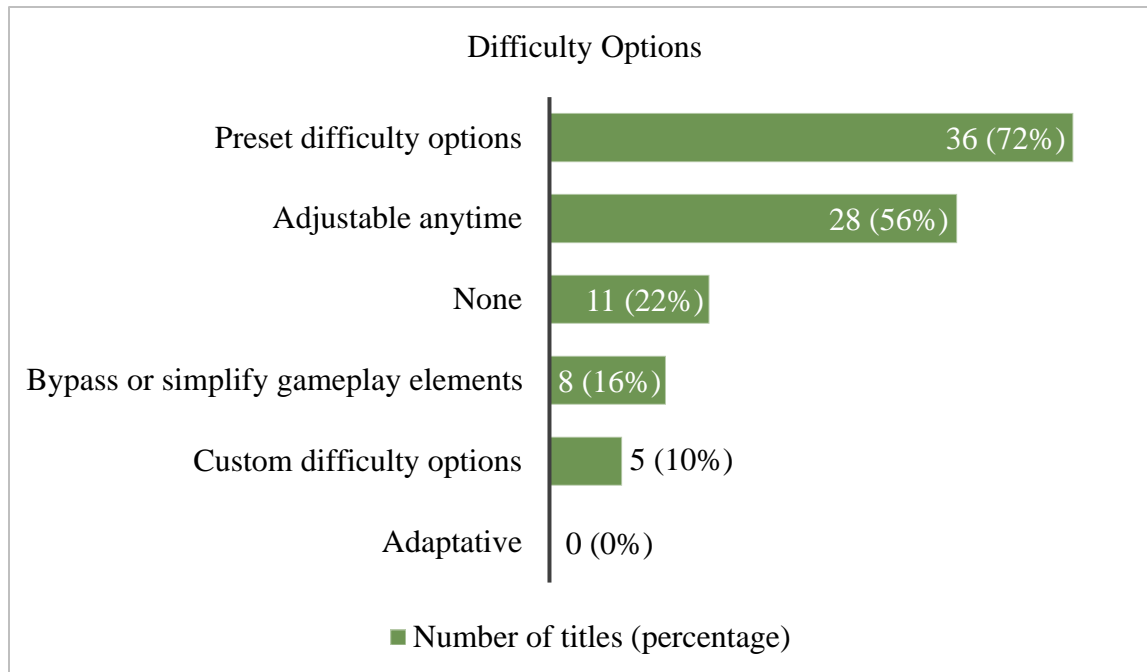


Figure 13. Results of the different difficulty settings present in action/adventure games.

According to the GAG, the level of accessibility of the general section is intermediate. This research reveals that a substantial number of games comply with the only basic guideline in this section (preset difficulty), while they fall behind with intermediate features, especially related to difficulty and manual saving. Among the strengths, the investigation shows that preset difficulty and aim assist are in average widely common. According to the results, the general section complies with 72% of basic guidelines and 40% of intermediate guidelines, which means that 44% of games comply with general guidelines. The implementation of more general guidelines is a benefit and improves the game experience not only for persons with disabilities, but for all types of users, and, while at a first glance they may not look important for accessibility, these guidelines can truly mark a difference in the ability to play a game.

Guideline and result separated by GAG category					
	Basic		Intermediate		Advanced
	Preset difficulty	72%	Autosave	84%	None
			Aim assist	80%	
			Difficulty adjustable any time	56%	
			Manual save	32%	
			Bypass or simplify gameplay elements	16%	
			Custom difficulty	10%	
			Adaptive difficulty	0%	
Average percentage of games that have a guideline by category	72%		40%		
Average percentage of games that have general guidelines	44%				

Table 1. Results of each general GAG.

Auditory

With respect to hearing, the research reveals mostly unfavorable accessibility results with the exception of volume settings and subtitles. Firstly, an overwhelming majority of titles have at least one volume control. GAG suggest separate volume controls to allow user customization of sound levels (Ellis et al., “Provide separate volume controls”). All games let players adjust the level of music (see figure 14), 80% allow users to customize dialogue voices, and 78% have a sound effect slider. The option “Master or All” seems more dispensable than the other three because many developers opt to not include this slider in their games (38%). The study shows

that PC action/adventure game makers are already a step forward with this volume guideline; nevertheless, they need to pay more attention to other auditory guidelines such as monoaural and speech-to-text.

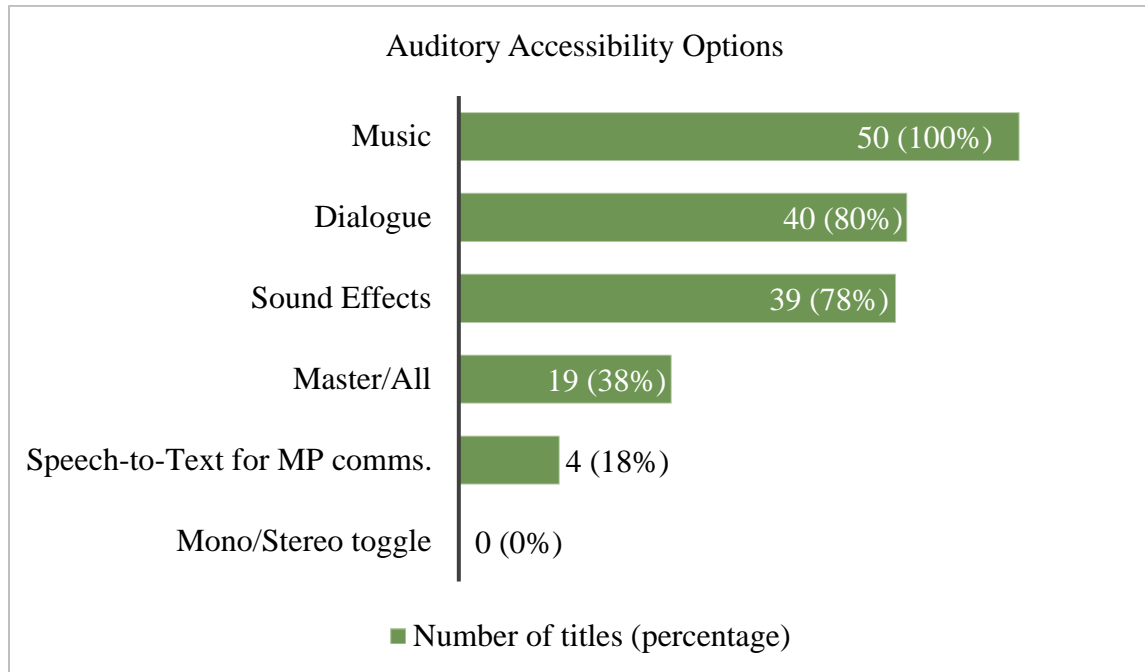


Figure 14. Auditory accessibility guidelines.

A monoaural (mono) option is vital for users who have hearing in one ear only. This basic hearing functionality is absent in every evaluated game (see figure 14 above). The mono toggle function to switch all audio to one position (also useful to be able to hear everything from one ear while using earphones) is completely missing. Nonetheless, the platform, in this case, Windows 10, provides a monoaural option to fill this gap left by games. Another accessibility tool for non-hearing users that is widely absent is speech-to-text (STT) for multiplayer communication (voice chat). STT converts spoken language from other players in multiplayer games to text on-screen. Out of the 22 releases of the investigation with a multiplayer module, most of them lack this important and required feature because only 4 (18%) have STT (see figure 14 above). These four games with speech-to-text are all published by Ubisoft: *Far Cry New Dawn* (2019), *Far Cry 6* (2021), *Watch Dogs Legion* (2020), and *Tom Clancy's Ghost Recon Breakpoint* (2019). The native lack of support of these features obstructs players with auditory limitations and interferes with player-to-player communications.

Subtitles

The second hearing and basic accessibility guideline that all investigated games comply with is subtitles: all 49 titles with voiced dialogue have subtitles. Another noticeable aspect in this regard, is the fact that 98% of subtitles are adjustable at any time (see figure 15 below), which means that the user can enable and disable subtitles during gameplay. Moreover, a respectable number of titles (55%) have the option to set a subtitle background (this feature dates back to 2010 with Assassin's Creed 2). However, the rest of subtitle guidelines need improvement. Only a quarter of the action/adventure games of the study have options to adjust

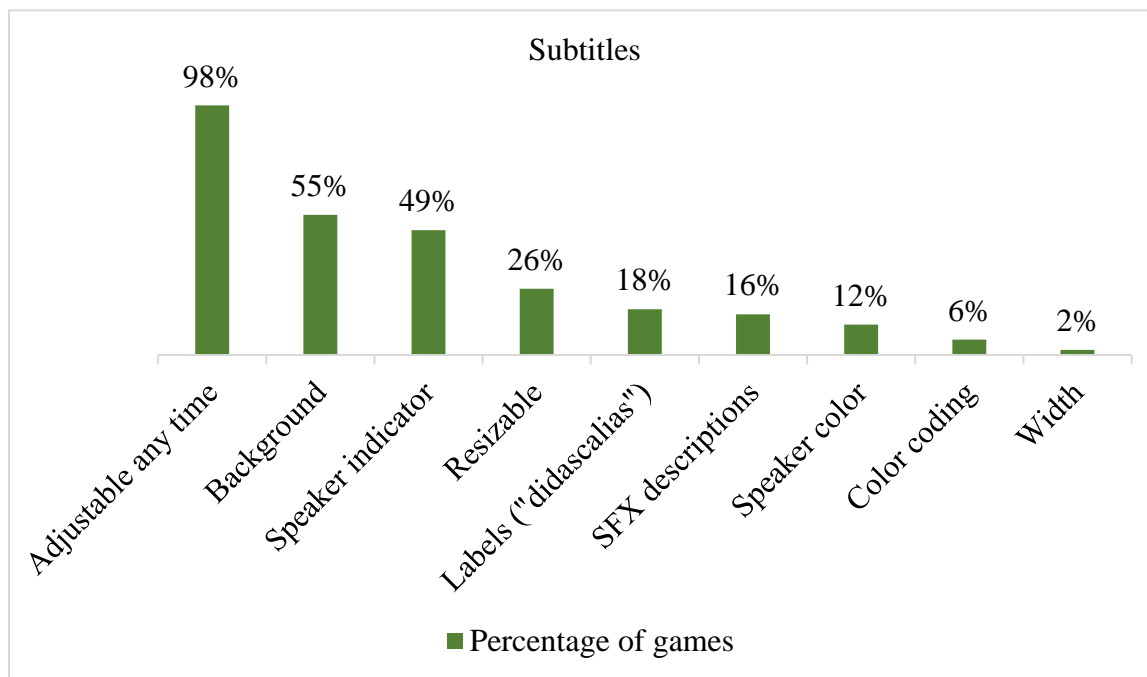


Figure 15. Results of subtitle guidelines.

the size of subtitles. A publisher that started to include this feature in the majority of their productions is Ubisoft. Their first title with this feature was AC Odyssey in 2019 and every following major action/adventure franchise iteration (AC, Far Cry, Immortals Fenyx Rising, Tom Clancy's Ghost Recon, and Watch Dogs) has released with that option available. With respect to width (see definition in appendix 1), only one game (Watch Dogs Legion) has this option, which means that 98% of the games do not allow the user to adjust spacing between subtitles for better readability. The results obtained on general subtitle guidelines demonstrate that subtitle customization is not the focus in the game industry.

Subtitles for the Deaf and Hard of Hearing (SDH)

The investigation also proves that SDH is not an essential accessibility feature in the group of reviewed video games. Even though 49% of the tested games have a speaker indicator, only 12% code speakers with distinct colors (see figure 15 above). Also, speaker colors do not appear to follow any standards for color assignment such as using a specific color for each character depending on their roles (main or secondary protagonists). Subtitles in these games are usually white, but the name of the speaker is colored and appears before the subtitle. Also related to color coding, just 3 games of the study (6%) allow the player to choose a color for the subtitles: *AC III Remastered* (2019), *Watch Dogs Legion* (2020), and *Dying Light 2* (2022). The lack of color coding and speaker names confuse players with deafness and prevent them from properly following the plot and identifying who is talking offscreen.



Figure 16. Speaker color and background in the subtitles of *Rise of the Tomb Raider* (2015).

A gaming-specific feature that supplements SDH is sound subtitles (also called directional subtitles). This is an option that, when enabled, displays auditory information on-screen and points in the direction of sounds. This is a method that games in this genre can use to relay sounds offscreen (when the sound is coming from a direction the player is not looking at);

for example, in several titles in the Far Cry series such as Far Cry New Dawn (2019) and Far Cry 6 (2021), sound subtitles display the captions “Shooting” when gunfire occurs and “Molotov” when this incendiary weapon is thrown near the player. Moreover, sound subtitles point to the source of the sound to help the player (figure 17). The three-dimensional quality of action/adventure games allow developers to enhance SDH with sound subtitles by communicating sounds through text in a more specific manner by indicating the direction of sounds.



Figure 17. Captions in Far Cry New Dawn (2019) describing the sound and its direction.

Even though this research evidences that the subtitles of these games are not for a deaf and hard of hearing audience, 9 games (18%) had labels for non-verbal speech and sound related nuances (tone of voice or other sound elements related to speech such as throat clearing, whistling, coughing, or laughing). The numbers do not change much with sound effects. A substantial majority of subtitles do not have sound descriptions either (only 16% describe sounds, see figure 15). A notable example of SDH is the Tomb Raider franchise published by Square Enix. The Tomb Raider games published in 2013, 2015, and 2018 have colors for speakers and labels for the description of non-verbal elements and sound effects. While this accessibility service is regulated in other audiovisual mediums such as television shows and

movies, SDH in video games (an audiovisual product with cinematics, action animations, and dialogue) have still a long way to go to be accessible.

Guideline and result separated by GAG category					
	Basic		Intermediate		Advanced
	Subtitles	100%	Background	55%	None
			Speaker indicator	49%	
			Resizable	26%	
			Sound subtitles	17%	
			Color (subtitles and speaker)	12%	
			Width	2%	
Average percentage of games that have a guideline by category	100%		27%		
Average percentage of games that have subtitle guidelines	37%				

Table 2. Summary of GAG results related to subtitles.

In accordance with the auditory results, the analyzed releases comply fully with the only basic accessibility guideline (subtitles), follow a third of the intermediate recommendations, and almost a fifth of the titles implement the only advanced guideline in this disability category (STT, see table 3 below). The average percentage of games that have auditory guidelines is 38%. In addition, STT needs more implementation in multiplayer titles. Gamers should not rely on the platform to fix a problem caused by the lack of an option or feature in-game such as a toggle between stereo and monoaural sound. This result also means that publishers and developers should focus more on adding customization options to subtitles and make use of deaf and hard of hearing subtitles to better reach this audience.

Guideline and result separated by GAG category						
	Basic		Intermediate		Advanced	
	Subtitles	100%	Volume controls	100%	Speech-to-text	18%
			Subtitles background	55%		
			Speaker indicator	49%		
			Resizable subtitles	26%		
			Sound subtitles	17%		
			Color (subtitles and speaker)	12%		
			Width	2%		
			Mono/stereo toggle	0%		
Average percentage of games that have a guideline by category	100%	33%	18%			
Average percentage of games that have auditory guidelines	38%					

Table 3. Summary of auditory GAG results.

Visual

With regard to image and interface options, the most popular adjustment is brightness (figure 18), which is present in 41 games, followed by gamma (16), and contrast (12) (see definitions in appendix 1). This result is satisfactory because only a handful of titles lack the option to adjust brightness and at least one of the three options is available in the majority of them. On the contrary, an accessibility feature that needs improvement is adjustable interface text, which is customizable in 8% of the titles (Far Cry 6, AC Valhalla, The Skywalker Saga, and Tom Clancy's Ghost Recon Breakpoint). In this regard, text size is the only adjustable option, whereas choices of color and font are not available (see adjustable interface text, interface font, interface size, and interface text color in appendix 1). The more options the player can customize, the better; for this reason, offering a choice of different fonts (for instance, a typeface for dyslexics) and colors is helpful.

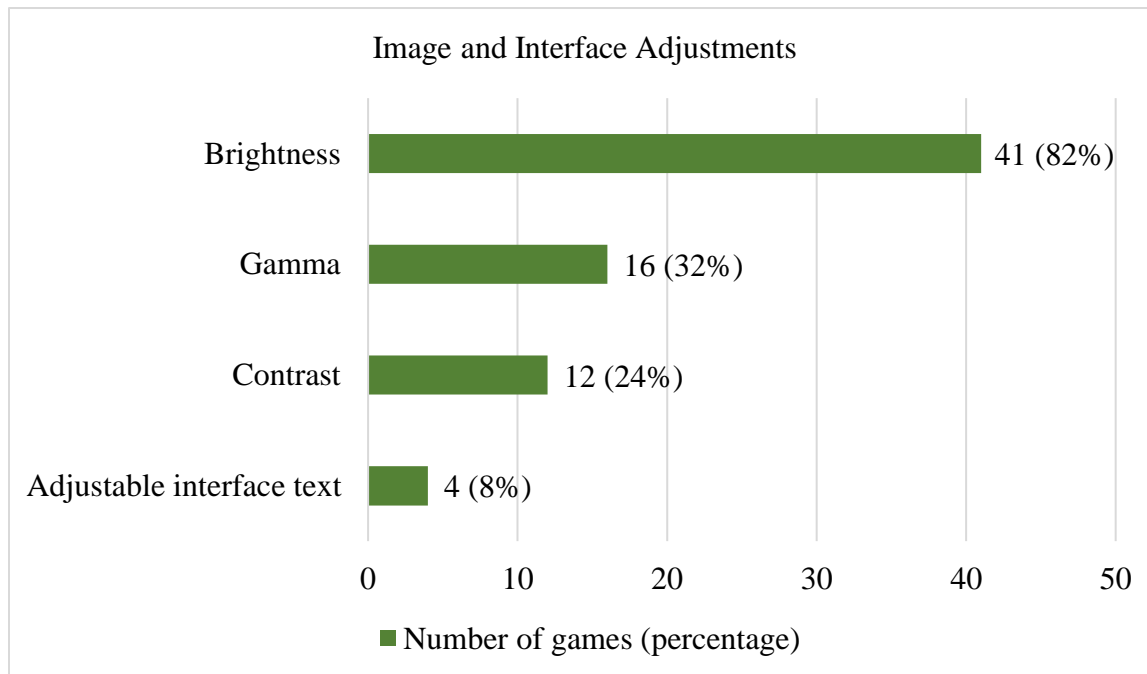


Figure 18. Results of visual adjustment options.

Another space for improvement is the implementation of a narrator that reads aloud the text appearing in the game. Out of the 50 analyzed releases, only 6 (figure 19) have screen narration. The oldest games of the study that include this option are Far Cry New Dawn and Tom Clancy's Ghost Recon Breakpoint by Ubisoft, both released in 2019 (all the titles in this research

that include screen narration are all developed by this French company). Screen narration is an advanced feature, and definitely, a tool that game studios should widely adopt. As a noteworthy detail in this section, the games of this study with screen narration currently use Windows narrators (that sound quite robotic) and not voice talents. Game developers should certainly explore the possibility of providing a less synthetic and more natural sounding experience with the help of voice overs recorded by human actors or artificial intelligence voice acting.

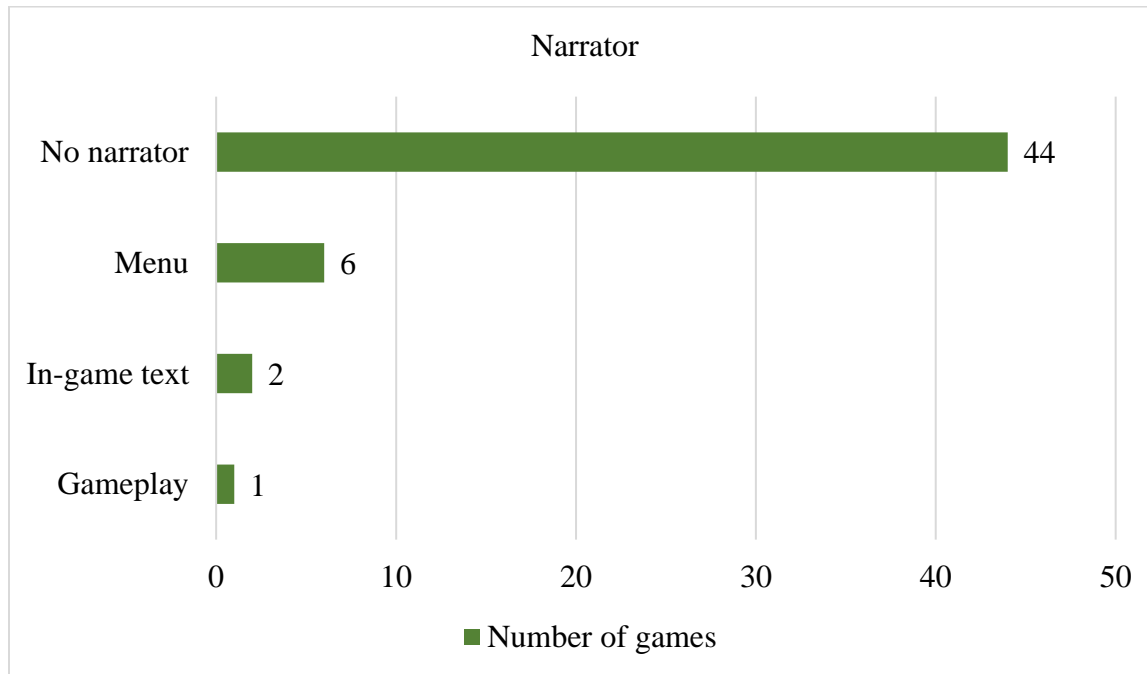


Figure 19. Results of games with screen narration.

Surround sound (see definition in appendix 1) is among other accessibility visual features that are commendably present (almost by default) in games. The majority (96%) support this feature that can help players with visual limitations guide themselves by the sounds of the game world (figure 20). With surround sound, users playing an action/adventure game (created in a 3D world) can identify the direction of in-game noise such as a vehicle passing by, firing, and explosions. They can also locate dangerous areas, key non-player characters, and important items by following their sounds.

Other accessibility options and features that were investigated are camera shakes and text-to-speech (TTS). A fourth part of the games of this research have the option to enable or disable camera shakes (figure 20). Camera shakes is an effect that occurs when the player moves their character or receives a hit in-game. This effect makes the camera shake to produce an immersive

sensation. However, this may result in making some users dizzy; therefore, to avoid this negative outcome, game makers should let players choose whether they want the camera to shake or not when this happens. Additionally, text-to-speech, an important means of communication for players who cannot read text messages from other players (for example, players who cannot speak communicating with players who cannot see without the help of an interpreter), is generally not supported (two games out of 22 have this feature, see figure 20). This means that this could be a quite recent accessibility feature as the first game in this group to implement TTS released in 2019. Also, the only two titles of the study that include both text-to-speech and speech-to-text are Watch Dogs Legion (2020) and Tom Clancy's Ghost Recon Breakpoint (2019). The absence of these features creates unnecessary visual hurdles, which is the case in a considerable number of titles.

The study also reveals that a small number of games let the players turn off screen effects (see screen flashes toggle in appendix 1) and that none have screen magnification options. Screen effects include screen flashes and other effects that distort the screen when the character is poisoned, drunk, or in another state. According to the results, most titles do not allow the player to adjust these effects (only 7% have this option, see figure 20). The investigation also proves that none of the computer games have a native screen magnifier. Nonetheless, the Windows 10 operative system provides a magnifier that players can use to solve the lack thereof in games. Screen effects may interfere with gameplay by causing seizures or headaches, while the lack of screen magnification imposes extra steps because users have to resort to a third-party application instead of activating the function that could be readily available in-game.

The last analyzed visual guideline is audio description (AD). None of the tested releases have an audio description track. However, as a side note, game trailers are releasing with audio described versions ("God of War"; "Mario + Rabbids"), and in the Game Accessibility Conference held in April 2022, Ian Hamilton pointed out that "multiple companies [are] working on integrating [audio description] directly into games for things like cutscenes" ("News Update"). A common accessibility feature present in movies and television shows is absolutely absent during gameplay in video games. Moreover, electronic games can undoubtedly implement partial AD in game sections such as cutscenes, loading screens, and menus to describe physical appearances of characters or environments. Furthermore, a variety of action/adventure games

have concept art and character models that the player can access from the game menu (for example, the Batman Arkham series). To comply with this game accessibility guideline, game developers could use AD in these sections of the game apart from audio describing cutscenes.

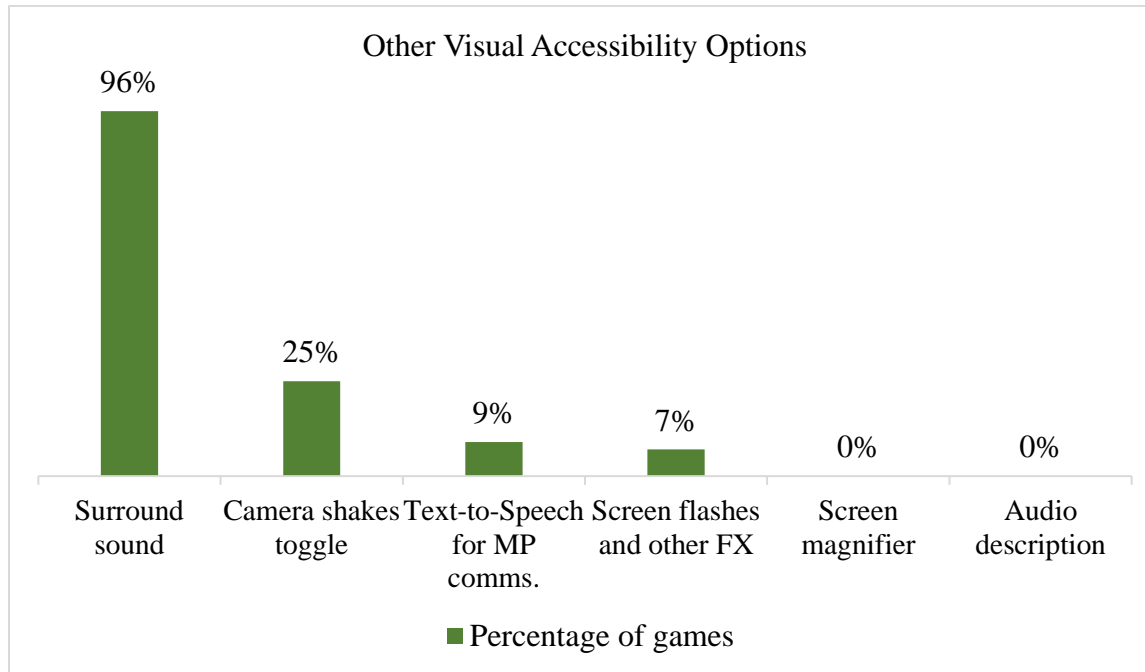


Figure 20. Results of other visual GAG.

Color

Another notable accessibility option that is generally absent is a setting for colorblindness (see colorblind mode in appendix 1). Only 20% of the titles include a colorblind mode (figure 21). The absence of a colorblind mode does not mean that the game needs one. Games may portray information not by color alone and, therefore, may not need a colorblind filter; nonetheless, this evaluation is outside the scope of this research. This investigation only demonstrates how many computer games have a colorblind option available. In addition, games should have an option that allows players to change the colors of important heads-up display (HUD) elements. This option is widely unavailable in the action/adventure releases of this research as the results show 4% of the sample have an option to customize the color of the reticle and 2% of the map (including icons). None of the evaluated games have options to change the color of the cursor or the game menu.

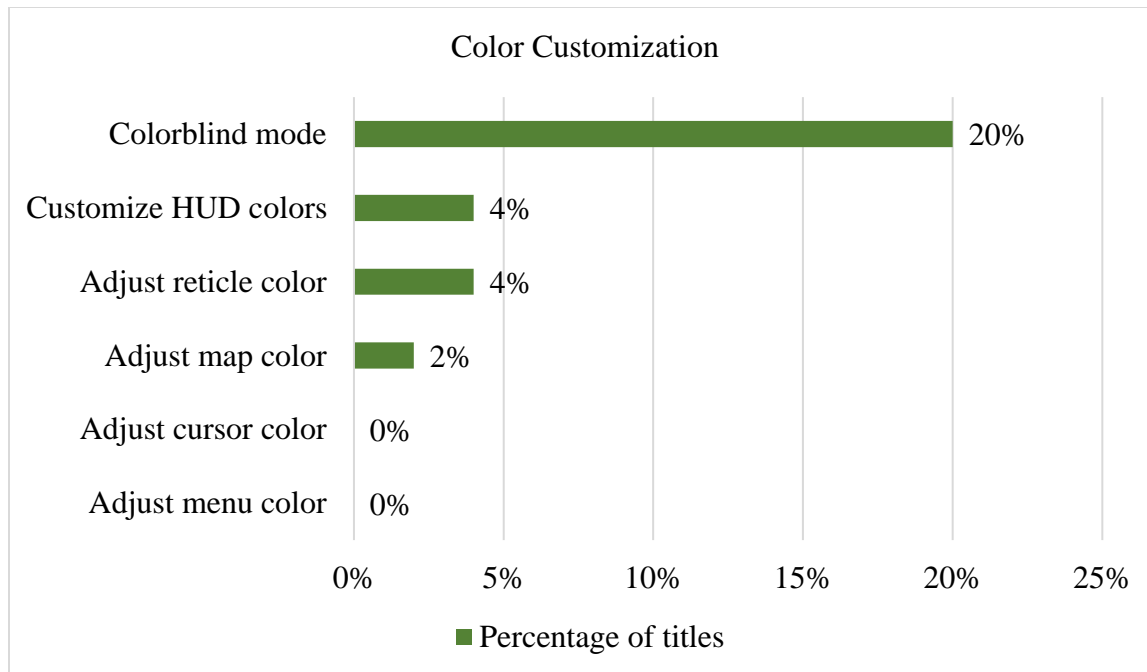


Figure 21. Results of color customization options.

To further customize the experience for colorblind users, 6 game titles (out of 50, see figure 23) go the extra mile and include colorblind filters for specific color deficiencies: tritanopia, protanopia, and deuteranopia (see definitions in appendix 1). Three games also include adjustable color filters (see colorblind filters in appendix 1) that allow the user to customize from a wider range of colors instead of preset ones. Strikingly, none of the computer games have a setting for gamers with monochromacy (see definition in appendix 1). However, once again, Windows 10 also has native colorblind settings. In this case, the platform provides colorblind filters for these three main groups (tritanopia, protanopia, and deuteranopia) plus monochromacy, but games should include filters natively, according to GAG. In conclusion, colorblindness is another area where game accessibility can improve.

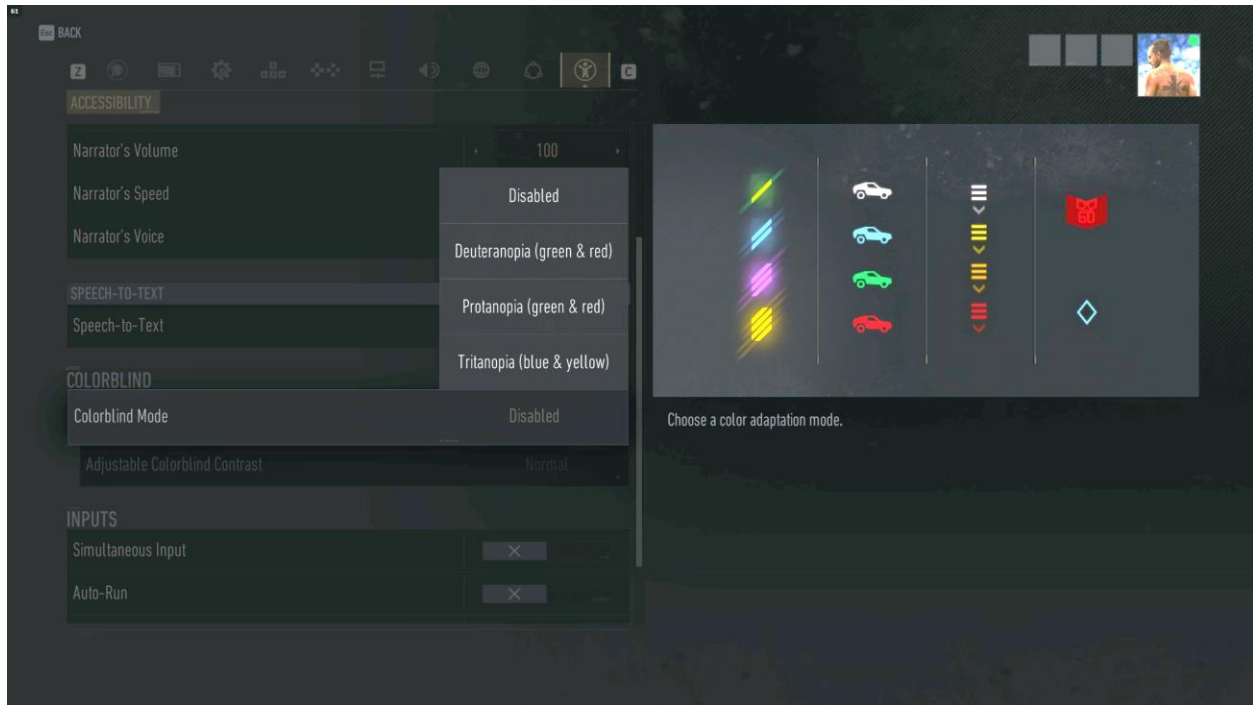


Figure 22. Colorblind filters in Tom Clancy's Ghost Recon Breakpoint (2019).

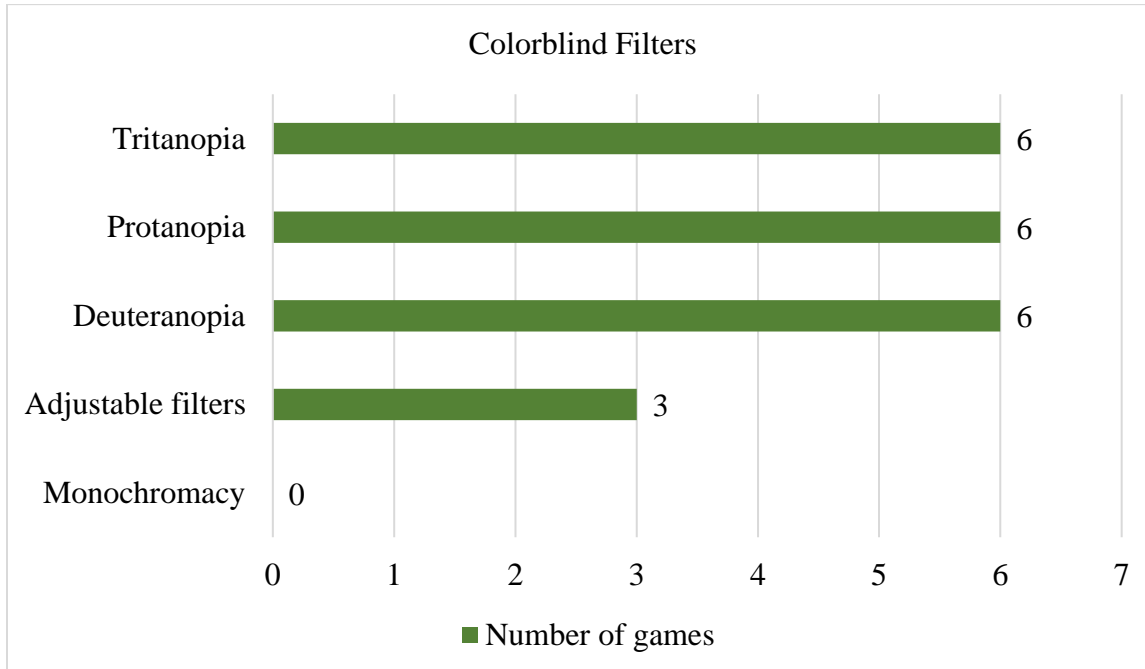


Figure 23. Results of colorblind filter options.

Altogether, the results of the visual accessibility options are concerning because the average percentage of games that have a visual guideline contemplated in the GAG is low (25%, see table 4). The only two guidelines that are largely present are surround sound and contrast options, while the rest have a shortage of support (no more than a fourth of titles implement the remainder of visual guidelines). These numbers suggest that the action/adventure genre is ill suited for gamers with visual disabilities because of the health hazard exposure of screen flashes and camera shakes, and also due to the lack of implementation of features designed for players with visual limitations (such as AD, screen narration, adjustable UI, and colorblind options) that would enable them to play this type of releases without restrictions.

Guideline and result separated by GAG category						
	Basic		Intermediate		Advanced	
		Colorblind mode	20%	Surround sound	96%	Narrator
	Contrast options			82%	Text-to-speech	9%
	Camera shakes toggle			25%	Audio description	0%
	Colorblind filters	16%	Adjustable interface text	8%		
			Customize HUD color	4%	Adjustable interface font	0%
Average percentage of games that have a guideline by category	18%		43%		5%	
Average percentage of games that have visual guidelines	25%					

Table 4. Summary of visual Game Accessibility Guidelines results.

Motor

In regard to the guidelines related to control and mobility, a substantial amount of the studied action/adventure releases do not have the option to change repeated button pressing (77%, see figure 24). Moreover, a meager 21% of games have the option to change continuous pressing to a hold and a paltry 12% have the option to instead use a button tap. The percentage of electronic games with both options is even lower (9%). Players can perform repeated actions in-game by tapping a button continuously. Releases, such as *Red Dead Redemption 2* (2019) and *Grand Theft Auto V* (2015), make the player tap a button repeatedly to sprint. This mechanic should come with the option to change tapping to a button hold or a single tap to avoid player fatigue and possible physical pains and to simplify the experience for players with restricted mobility instead of creating another unnecessary challenge.

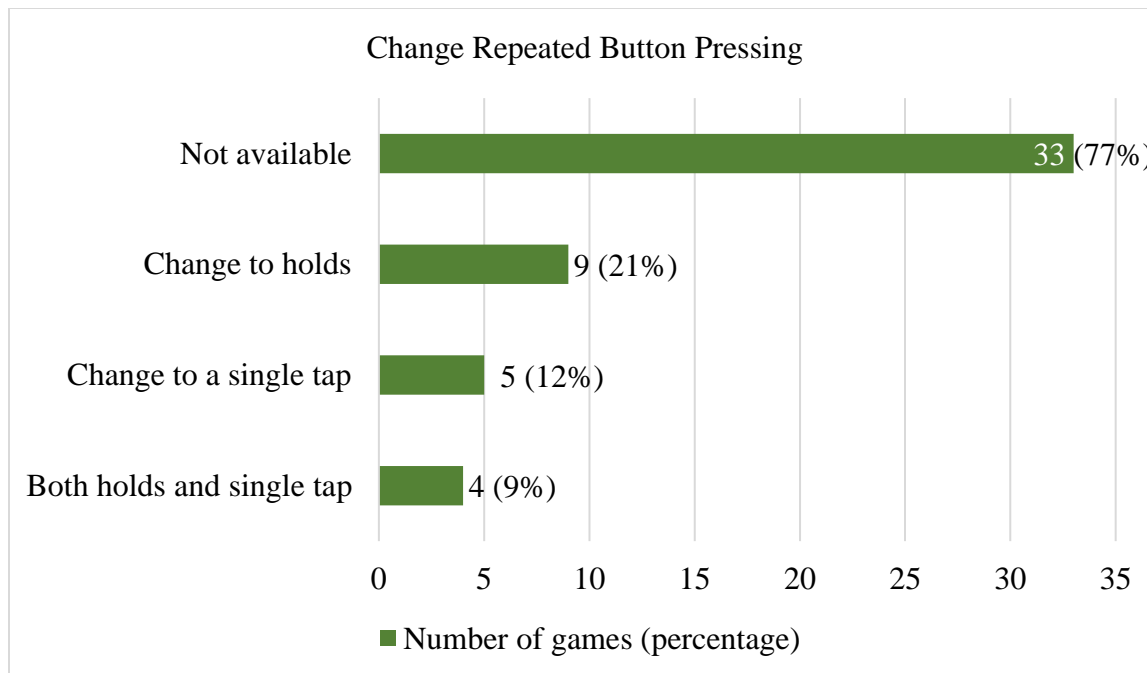


Figure 24. Games with the option to change repeated button tapping.

Similarly, the option to change button holds to toggles (presses) is missing in the majority of games. In the case of the action/adventure genre, button holds commonly occur when the player has to aim a weapon, sprint, or crouch. These actions are core to gameplay; therefore, the user performs them throughout the game. The investigation shows that 55% of the games have the option to toggle between a hold and a press available (figure 25). Moreover, constantly holding a button to perform these important actions may result bothersome for some gamers.

Including a toggle is an intermediate recommendation (Ellis et al., “Avoid/provide alternatives”) that improves accessibility because the player only has to press a button once to execute important actions in-game such as crouching, aiming down sights, running, or standing up (see change holds to presses in appendix 1).

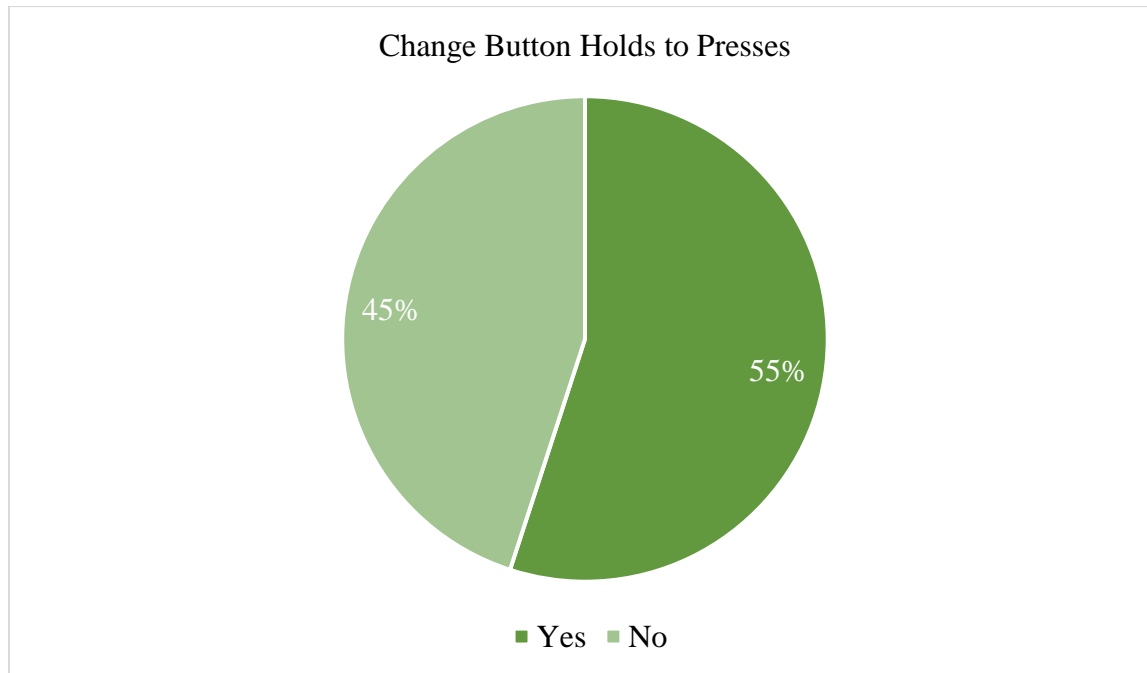


Figure 25. Percentage of games where the user can change button holds to presses.

Another game mechanic related to the motor category is quick-time events (QTE, see expanded definitions in appendix 1) and how these are handled. A quick-time event is a situation that requires the player to press a button quickly. Some examples are QTE boss fights (e.g., Rais boss fight in *Dying Light*), animal encounters (e.g., fighting a tiger in *Far Cry 3*), and, although not included in this study, interactive action/adventure dramas (such as *Heavy Rain*, *Beyond Two Souls*, and *Detroit: Become Human* by Quantic Dreams). Out of the 50 releases of this research, only 32 titles implement QTE mechanics. A large majority of these (23 games or 72%, see figure 26) make the player encounter a QTE with a single button press. QTE requiring repeated presses and button holds are present in 56% and 41% of the titles, respectively. Only two games of the study (*Lego Star Wars: The Skywalker Saga* and *Days Gone*) have an autocomplete QTE function, and only one game (*AC Valhalla*) has the option to turn these events off altogether. In conclusion, the findings prove that autocomplete or turn off QTE (the most accessible methods to deal with this mechanic) are the least favored by game developers

because only three releases include these accessibility options for QTE handling. Therefore, players who need more time to react have increased problems playing these games. Not offering the option to autocomplete or turn off QTE is a major unnecessary impediment and developers should focus on including these accessible options to make these situations completely incapable of altering the gaming experience for users with disabilities.

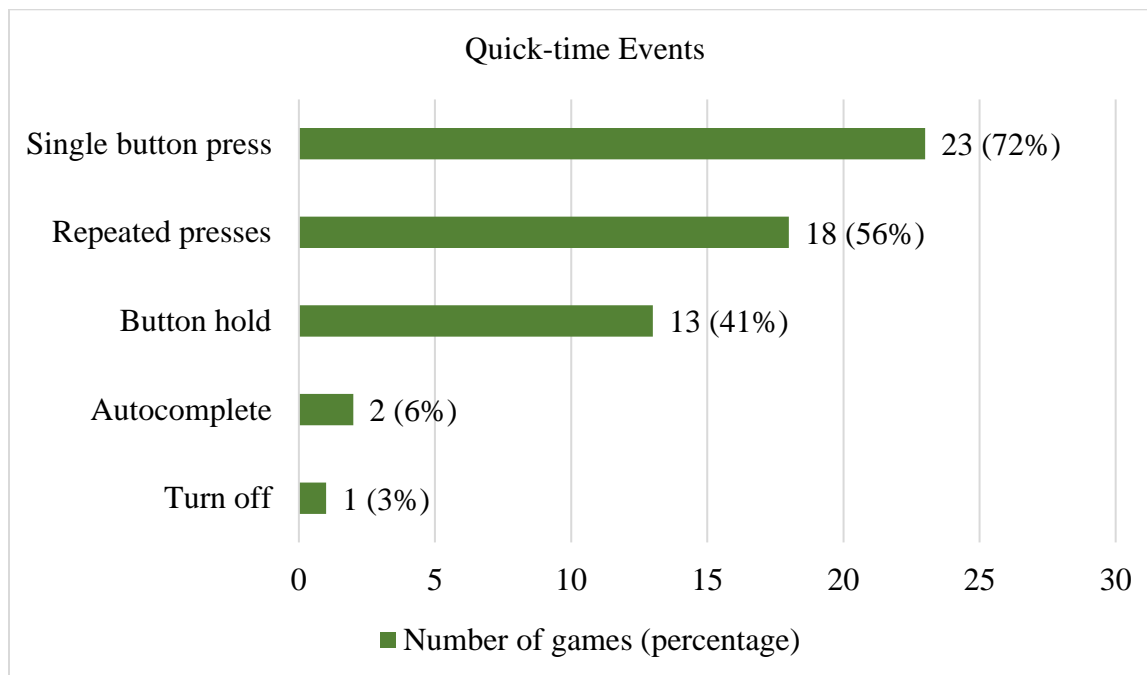


Figure 26. Results of quick-time event handling options: how the user has to deal with a quick-time event.

Other important motor guidelines include keyboard and mouse rebinding, controller vibration toggle, and eye tracking functions (see definitions in appendix 1). The results related to key rebinding are among the strengths of motor accessibility. The ability to change key and button assignments is a popular feature and almost omnipresent in action/adventure computer games. An overwhelming 94% (or 47 titles, see figure 27) allow the player to fully customize key bindings. Controller vibration is another feature that users can change in the majority of games. The results show that most games have an option to turn off the vibration of the controller (92%). On the contrary, and one of the weaknesses of motor accessibility, eye tracking is not broadly supported. Eye tracking is a system that helps players control the game with their eyes. This is also an advanced feature according to GAG (Ellis et al., “Provide very simple control schemes”). Unfortunately, a little over a quarter of the games are compatible with eye

tracking (figure 27). On the one hand, franchises such as Far Cry, Watch Dogs, Assassin's Creed, Tom Clancy's Ghost Recon, and Tomb Raider did not include eye tracking in their earlier releases, but included this assistive technology in their most recent iterations. On the other hand, other studios, such as Polish developer Techland, dropped this feature with their recent release of Dying Light 2 (eye tracking is available in the first Dying Light game). Hopefully, more games will release with eye tracking features or will add compatibility in future updates.

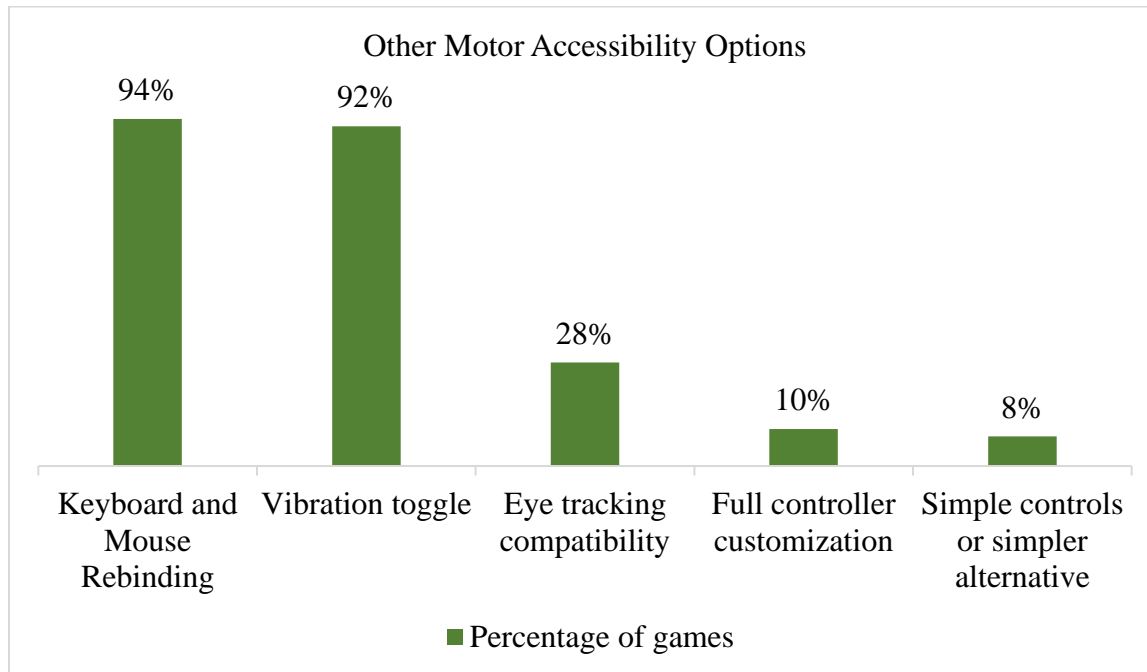


Figure 27. Results of other motor options that pertain to controlling movement.

Regarding accessibility options for controller users, an alarming 10% of games allow the players to fully customize the controllers (see full controller customization in appendix 1), including buttons and sticks (see figure 27 above). The results of partial controller customization (see definition in appendix 1) are better with 48% of games allowing players to at least change the controller scheme or switch sticks and buttons, while 42% do not have any customization option whatsoever for controllers (see figure 28 below). Furthermore, the number of games that offer easy controls or a simpler alternative is insignificantly small: 4 (or 8%, see figure 27 above). These games are The Pathless (this title offers several buttons to perform the same actions, e.g., the player can jump not only with the X button, but also with R1; consequently, the user has several buttons to choose from to perform the same action), Far Cry 6 (one handed mode: a controller scheme for playing with one hand only), AC Valhalla, and Immortals Fenyx

Rising (these last two titles have automovement, a function that enables the character to move automatically with the press of a button and without the need for more inputs).

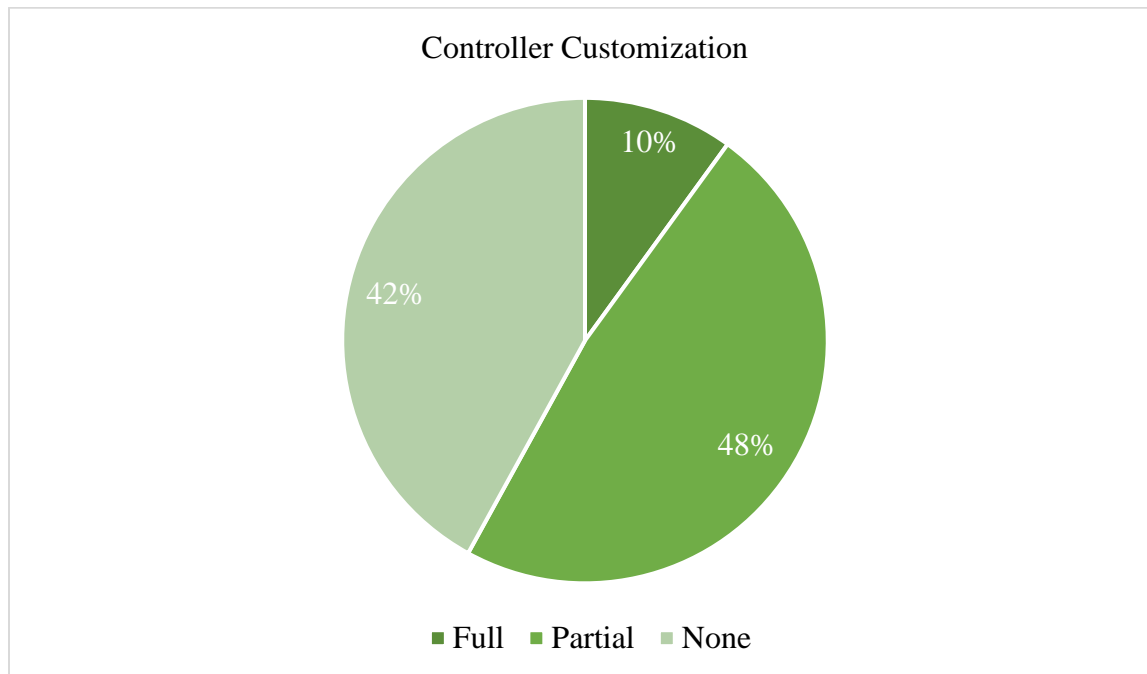


Figure 28. Controller customization options.

Concerning intermediate motor accessibility options, all user interface (UI) areas in the reviewed games are accessible using the same input method as the gameplay (figure 29); therefore, users can navigate the game UI with the same controller, mouse, or keyboard they use to play the game itself. This also means that all games support more than one input device and not only controller or a mouse and keyboard combination (see figure 29). Another guideline present in a greater part of the researched titles is windowed mode (82% have this option available, see figure 29). A game running in windowed mode (see definition in appendix 1) does not occupy the screen exclusively and provides more compatibility and multitasking opportunities for the PC user. Interestingly, most of the games that do not include windowed mode released before 2015, with the notable exception of Metro Exodus Enhanced Edition, a game released in 2021 that still lacks this option. Overall, this is a fairly common characteristic and developers enabling windowed mode allows the user to comfortably control other accessibility tools such as a screen narrator or a magnifier at the same time and on the same screen space as the game.

Another accessibility option that is not generally implemented in the genre of this study is protection against unintentional inputs (also known as post acceptance delay, see definition in appendix 1). Only two games (4%) of this investigation support this feature (figure 29): Tom Clancy's Ghost Recon Wildlands (2017) and Red Dead Redemption 2 (2019). This feature lets the user control when to trigger an action after pressing a button for a certain amount of time. This option greatly benefits players who involuntarily move their hands or fingers and keeps them from performing undesired in-game actions when holding a controller. Game speed (see definition in appendix 1) is another accessibility feature that is absent in action/adventure games. Even though a mechanic to slow down time while aiming, evading, or driving may already be present in a game (for example, firing a special arrow in Immortals Fenyx Rising or evading a hit in Assassin's Creed Valhalla slow down time to facilitate control, or activating Dead Eye in Red Dead Redemption 2 and Driving Focus or Area Kill in GTA V also make the player enter a bullet-time state to assist with driving and aiming), gamers cannot activate this feature permanently or whenever they want to in the settings. These games have the potential to include game speed customization as an option, while other games offer this as an unlockable feature (e.g., The Last of Us Part II).

To conclude with the motor guideline results, none of the researched games have a macro system for controls or offer alternatives to precise timing. A macro system is an intermediate feature that allows users to program one key that, when pressed, triggers several combinations of keystrokes to assist with repetitive tasks. Fortunately, technology companies have developed gaming software for Windows that feature macro programming (some examples include Razer Synapse and the Mouse and Keyboard Center by Microsoft). In addition, precise timing is essential to gameplay in action/adventure games. Unfortunately, as per the guideline (Ellis et al., "Do not make precise timing"), all the releases of this investigation lack alternatives, or actions that can be carried out while the game is paused, or even a skip mechanism (except games such as Red Dead Redemption 2 or GTA V where players can advance through mission checkpoints; however, this feature was assessed already in the general section of this study in "bypass or simplify difficulty"). Other PC titles of the action/adventure variety, such as Final Fantasy XV with Wait Mode ("Final Fantasy XV") and Final Fantasy VII Remake with Battle System ("Final Fantasy VII Remake"), allow players to "pause" the game to perform actions. Likewise, other

game genres rely on this feature such as turn-based strategy action titles like XCOM, but due to the limitations of this research, these titles and genres were not part of the investigation.

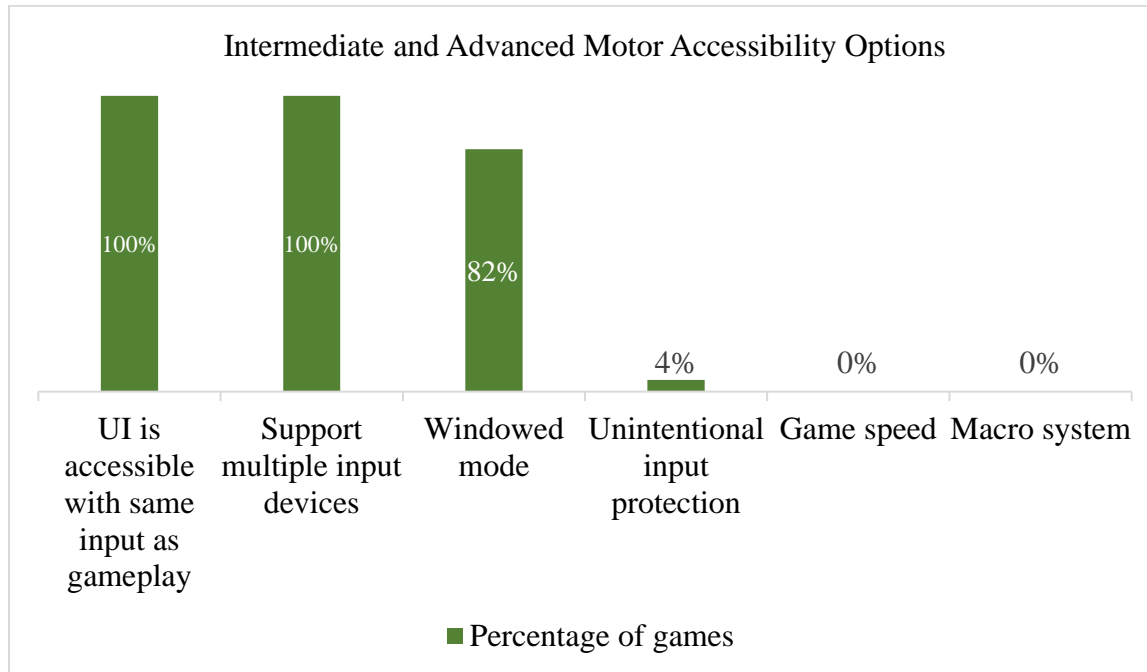


Figure 29. Results of intermediate and advanced motor accessibility options.

In conclusion, the results of motor GAG reveal that 73% of the selected games comply with basic guidelines, 41% with intermediate, and 11% with advanced (see table 5 below). If developers want to make games more unrestricted for gamers with motor disabilities, they should focus on making QTE accessible through an option to turn them off entirely or to complete them automatically (without user input). Additionally, they should support eye tracking, employ an unintentional input protection system, allow game speed customization, add native macro settings, and be mindful of how the user could conduct actions while the game is paused or make game mechanics simpler and skippable for those with motor limitations.

Guideline and result separated by GAG category						
	Basic		Intermediate		Advanced	
		UI areas are accessible with the same input as the gameplay	100%	Support more than one input device	100%	Eye tracking
	Windowed mode			82%		
	Keyboard and mouse rebinding	94%	Change holds to taps	55%	Post acceptance delay	4%
			Accessible QTE handling	9%		
	Controller customization	90%	Game speed	0%	Can carry out actions while paused or a skip mechanism	0%
	Simple controls or simpler alternative	8%	Macro system	0%		
Average percentage of games that have a guideline by category	73%		41%		11%	
Average percentage of games that have motor guidelines	44%					

Table 5. Summary of the results of motor Game Accessibility Guidelines.

Cognitive

Cognitive accessibility guidelines are the recommendations that most of the tested action/adventure games already follow. Starting with tutorials, every title has a teaching phase that explains how the user can play the game (figure 30). Also, the tutorial is available to the player at any time during gameplay in 86% of the cases. In-game guides are helpful for users with memory and learning problems. Tutorials also ease the process of returning to a game that the user has not played for a long time. Continuing with tutorial results, 26% of the titles have a tutorial that is interactive (see interactive tutorials in appendix 1), i.e., the tutorial requires player interaction to continue (push of a button to perform the action the tutorial is presenting). Moreover, in action/adventure games, the player can upgrade their character or acquire skills, powers, or moves that expand gameplay usually through the game menu and 16% of games go an extra step with tutorials and include a video in this menu (see video tutorials in appendix 1) to highlight how the character performs the action along with more information such as what buttons to press. Some examples of games that have a video to show these abilities are Horizon Zero Dawn (released on PC in 2020), Batman Arkham Knight (2015), Dying Light 2 (2022), and God of War (2022). Even though every evaluated game includes a tutorial, these in-game guides are presented in the form of text. Due to this reason, tutorials displaying on-screen are out of reach to gamers with visual disabilities during gameplay. However, a screen narrator can perhaps help to improve accessibility in this regard.

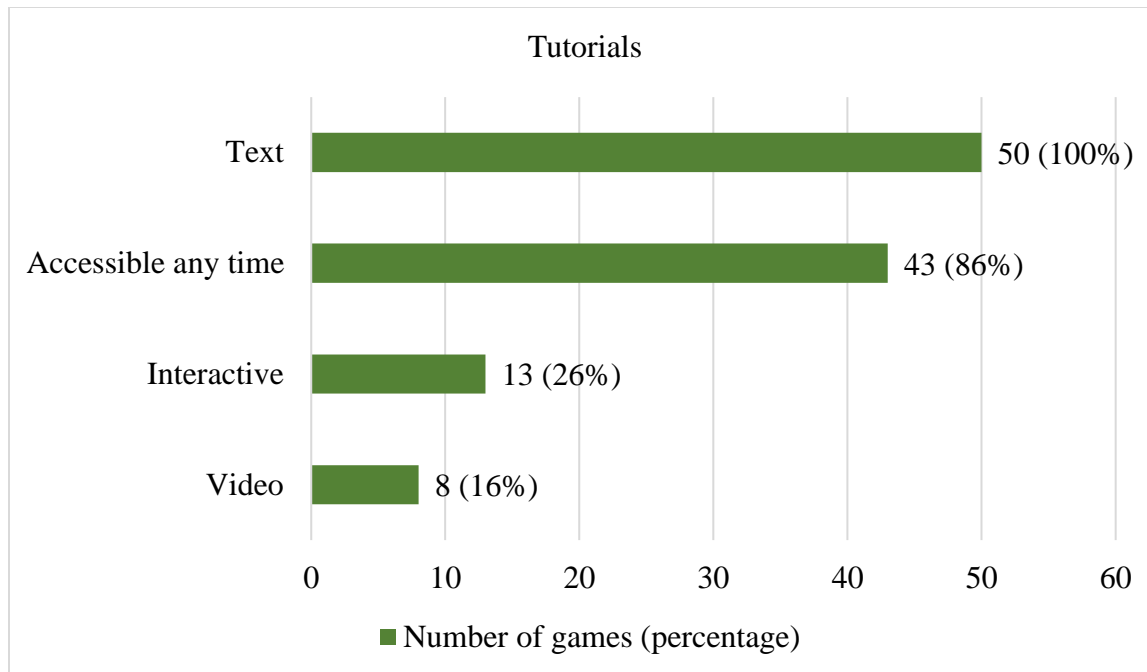


Figure 30. Tutorial results.

Intermediate and advanced cognitive options are also among the recommendations that are in line with the Game Accessibility Guidelines. Firstly, the player can start an action/adventure game without the need to navigate through multiple levels of menus in all the evaluated games (figure 31). This means that games are easy to start. Normally, a game in this genre loads into the main menu where the player must select “Start Game” (or “Continue,” if applicable) and, in a matter of seconds, the user is in the game. On the contrary, other titles, due to the nature of their genres (examples include strategy or role-playing games), require the player prepare or plan the game (preparation phase) and, therefore, go through multiple menus to start playing. Secondly, action/adventure games excel at keeping the player informed because every title includes contextual in-game tips and reminders of controls (figure 31), and almost every game (98%) includes reminders of objectives during gameplay (see contextual in-game help and tips, reminder of gameplay objectives, and reminder of controls in appendix 1). In this manner, the player is aware and on the loop of what is happening, what they have to do, and where to go.

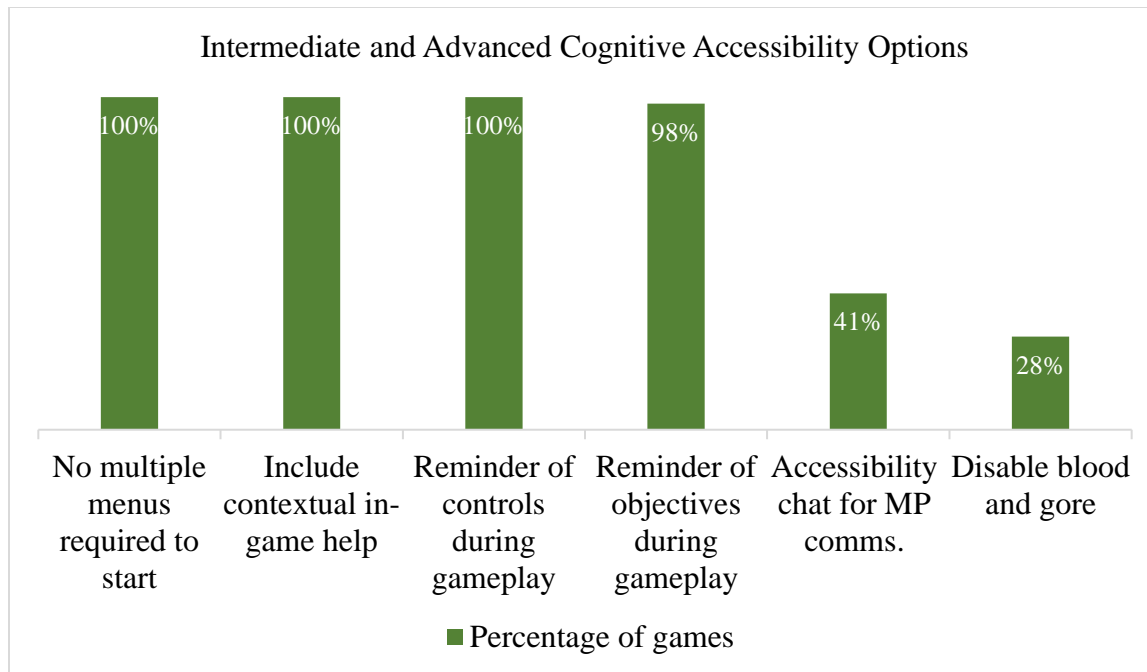


Figure 31. Results of intermediate and advanced cognitive accessibility options.

Contrastingly, accessibility chat and the ability to disable blood and gore are the less predominant cognitive accessibility features. In the video game context, accessibility chat is any tool that enables simple communications between players. In some games, this feature is enabled by including symbol-based chat or visual communication; for example, communicating through emotes (character gestures) in *Watch Dogs Legion* and *Red Dead Redemption 2*, via pings (signals) to show the other player where to go or where to look in *Shadow of the Tomb Raider*, or with a chat wheel in *Far Cry 6* to facilitate communication with preset messages. This is an advanced and necessary feature that from all 22 games with multiplayer, only 9 have (41%, see figure 31 above). With regard to blood and gore, a lowly 28% of games have a toggle to turn off the depiction of blood or dismembered body parts. This is partly due to the fact that blood is an immersive and realistic effect to include in games that, at the same time, disregards players who are sensitive to seeing representations of gore. The *Assassin's Creed* franchise (from 2010 with *AC 2* to 2020 with *AC Valhalla*) offers the option to turn off blood effects. Featuring an accessibility chat wheel with simple and preset messages and providing an option to turn off blood and gore from the planning phase of the game are welcome extensions of accessibility.

Generally, basic and intermediate cognitive guidelines are present in the studied games (100% and 99%, respectively, see table 6), while advanced guidelines are, in average, in 35% of

them. On the one hand, tutorials, no multiple menus required to start the games, in-game guidance, and reminders of controls and objectives are the strengths of action/adventure games. On the other hand, accessibility chat and blood and gore (advanced guidelines) are the features that need more attention. In conclusion, cognitive guidelines have the best accessibility results of the investigation with an 81% of games implementing them. This evidence suggests that action/adventure games are more accessible to people with cognitive disabilities than other types of disabilities.

Guideline and result separated by GAG category						
	Basic		Intermediate		Advanced	
	Tutorials	100%	Include contextual in-game help	100%	Accessibility chat	41%
	No multiple menus to start game	100%	Reminder of controls during gameplay	100%		
Reminder of objectives during gameplay			98%	Disable blood and gore	28%	
Average percentage of games that have a guideline by category	100%		99%		35%	
Average percentage of games that have cognitive guidelines	81%					

Table 6. Summary of results of cognitive Game Accessibility Guidelines.

Speech

Guidelines for speech disabilities, although few, received mixed results. Starting with the most favorable finding, none of the games require speech input (see definition in appendix 1), which means that the user can play them without speaking. The second negative outcome in speech accessibility (but positive for players in general and for those with visual disabilities) is voice chat (see definition in appendix 1). An impressively low 32% of games have text chat in comparison with the remarkably high 95% that support voice chat (see figure 32 below). The percentage of games that offer both means of communication is also 32%, and the percentage that have neither voice nor text chat is 5% (only one game: AC Unity). These results are based on the 22 games of this study that have a multiplayer component. Moreover, the collected data point out that game developers favor voice chat over text chat. The absence of text chat in-game excludes players who “[cannot] hear/talk, [do not] have the necessary hardware, have situational impairments such as a noisy room or [do not want] to wake the baby, or simply prefer not to use their voice” (Ellis et al., “Support voice chat”). Text chat is also a feature that recent franchise releases have dropped such as *Dying Light* (DL). Techland included both text and voice chat support in the first DL, but they dropped text chat support in DL2 as evidenced by the investigation and pointed out by an affected player:

I'm really pissed, because I'm deaf, and the friends that I played *Dying Light 1* for years with are also deaf, and this just completely crippled our ability to communicate directly in the game. Now, we have to resort to opening a Facebook Messenger window or communicate through our phones. This was a very inconsiderate move to not include text chat any more [sic].

(u/NicholasDavidKindred)

Even though communication in-game via voice channels is helpful and massively supported in the releases of the study, the exclusion of text chat disregards players with speech difficulties, those who do not want to use their voice, or the ones that do not have a microphone.

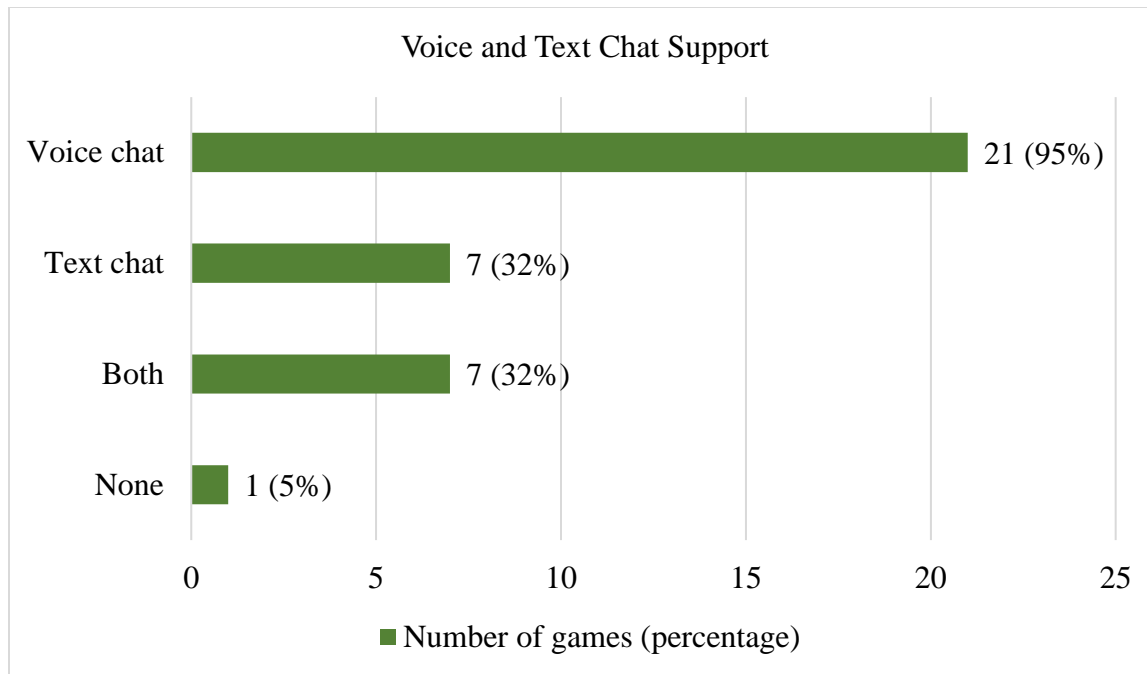


Figure 32. Results of voice and text chat support.

Another unsupported speech guideline is allowing “a preference to be set for playing online multiplayer with players who will only play [or] are willing to play [with or] without voice chat” (Ellis et al., “Allow a preference,” see online play with or without voice chat in appendix 1). This recommendation is completely absent as none of the games have an option to choose to play exclusively with players with voice chat enabled or disabled. This means that gamers cannot choose to play solely with others who, as themselves, do not want to enable the voice functionality. As a result, the system matches these players with others who have enabled voice chat, causing them to have communication problems.

To summarize the results of speech guidelines adherence, the support between voice and text chat is imbalanced because game makers offer the voice chat functionality more than text chat. In this study, all the games with text chat include voice chat, but not all the games with voice chat include text chat. This shortcoming hinders communications because every game with voice chat should also support text chat. Also, a toggle to choose to play only with players with or without voice enabled deserves more attention as to not place gamers in unpleasant situations due to lack of communication from the player that is not voice chatting. Lastly, no mandatory use of voice to control an action/adventure game should continue to be a staple of the genre to avoid unnecessary exclusion. Overall, the games of this investigation adhere to the only basic

guideline in this category but lack intermediate ones because 16% of titles support them. This means that the average percentage of releases that have guidelines for speech disabilities are 44%. Less than half of the analyzed games are prepared for gamers with voice difficulties.

Guideline and result separated by GAG category					
	Basic		Intermediate		Advanced
	No speech input required	100%	Text and voice chat support	32%	None
		Can play only with others with or without voice chat	0%		
Average percentage of games that have a guideline by category	100%		16%		
Average percentage of games that have speech guidelines	44%				

Table 7. Summary of results of speech Game Accessibility Guidelines.

Other Features, Options, and Game Mechanics that Boost Accessibility

Twenty games of the study have particular mechanics and tools that are also helpful for players with disabilities. Some of these are standard features of the studied genre such as a Global Positioning System (GPS). This tool is common in open world games and is present in 12 titles of this investigation (figure 33). In older releases (Grand Theft Auto IV, for instance) the voice GPS gives driving directions to the player; nonetheless, the games of this study do not have voice GPS and only resort to marking a route on the map or directly on the road to guide the player. Automatic driving and movement are among other game features that help with player movement in-game. By pushing a button or looking away from the road when shooting and driving in a vehicle, the player can activate autodrive or autowalking. These features make the vehicle or the character continue to advance on the road or head automatically to a previously selected point on the map. Far Cry games, Watch Dogs Legion, and Assassin's Creed Valhalla are good examples of automatic driving and walking. In Far Cry, the player can shoot in a car

and an artificial intelligence takes over driving. In Watch Dogs Legion, self-driving vehicles take the player wherever they want to go (the setting of the game is in a near future depiction of London). In AC Valhalla, automovement allows the player to move forward without holding any keys (“Enabling Auto-movement”). Other gameplay accessibility aids are visual indicators for danger close (present in first person shooter games such as Far Cry), turning off tinnitus sounds (Metro Exodus Enhanced Edition implemented a toggle to disable high pitch noises produced in-game after an explosion to increase immersion), collision sounds (an option implemented in AC Valhalla where the game produces beeps to indicate to a player when the character is colliding against a block), and one handed controller scheme (a preset controller scheme to play with one hand, present in Far Cry 6). These features make games more accessible by automating movement, easing mobility, and guiding the player with the help of sounds.

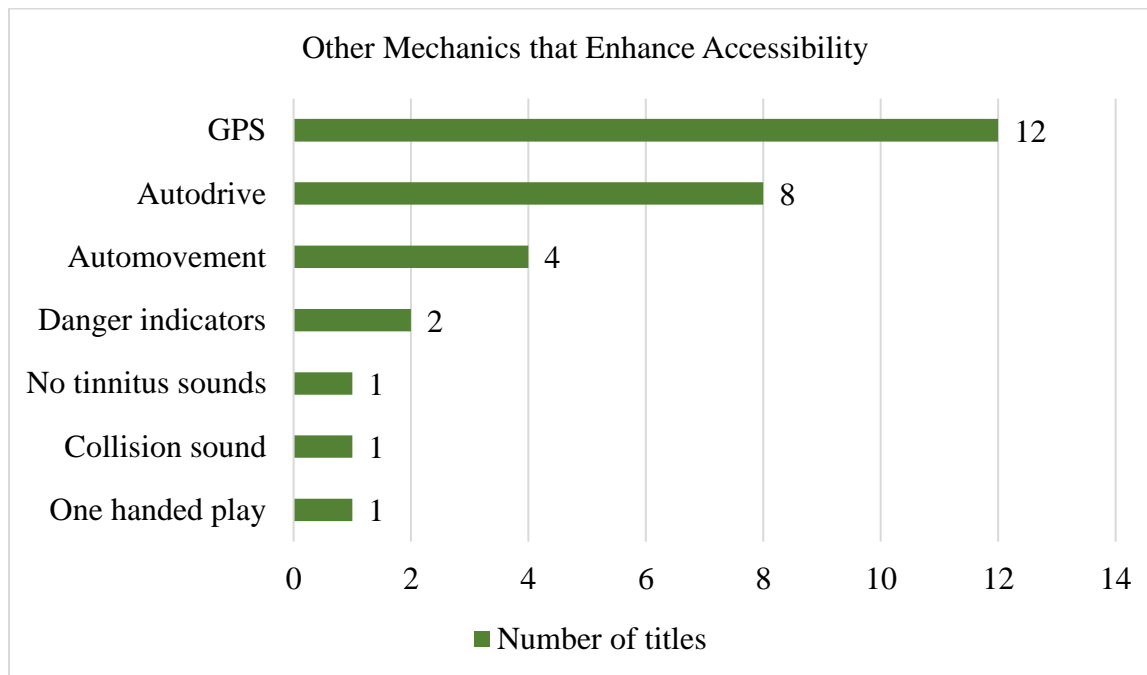


Figure 33. Results of other tools, options, and mechanics that enhance accessibility in action/adventure games.

Language Accessibility

The researcher also documented the language each game is localized to. Localization results include user interface, audio, and subtitles. Full localization is not available in all games (e.g., translation of UI, audio, or subtitles may be the only type of localization present). The results reveal that action/adventure games are localized into 31 languages and dialects

(figure 34). Furthermore, every game is available in five main languages: English, French, German, Italian, and Spanish (from Spain). This implies that if the native language of a gamer is not one of these five, that person may face language barriers in-game. Therefore, being bilingual (as long as the second language is one of the main five stated above) surely reduces language obstacles in the gaming space. Another interesting revelation from the results is that none of the game companies of this study localized their titles into Bulgarian and Vietnamese. These languages received zero results. The most relevant insight related to this investigation is the fact that games are available to a certain extent in many languages and thus can reach more players around the world.

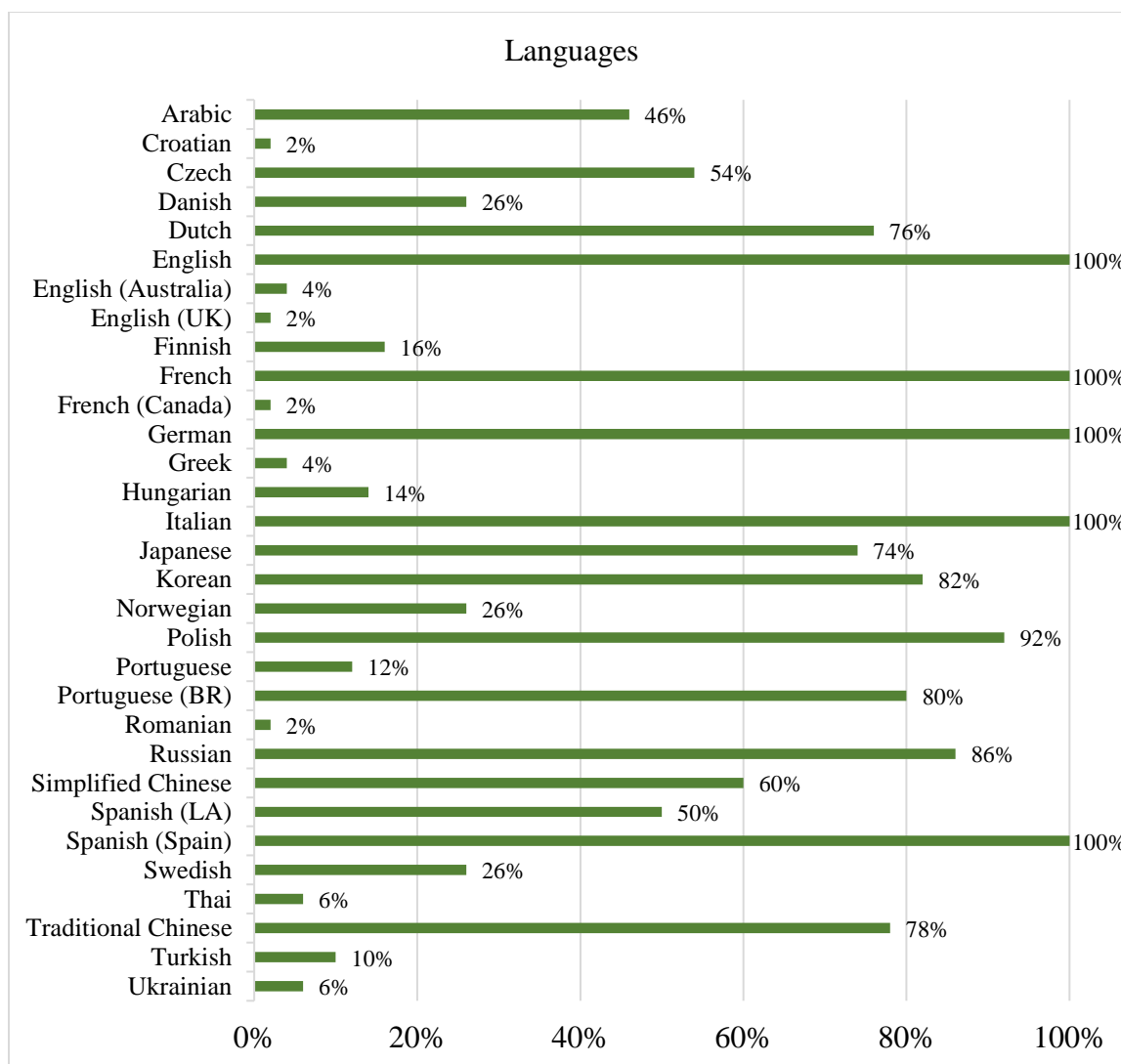


Figure 34. Language localization results.

Accessibility Trend Since 2010

According to the results, action/adventure games have become more accessible since 2010. Accessibility has been improving the most after 2016. This demonstrates a compromise within the video game industry to make titles more accessible (figure 35). Additionally, the year with the lowest level of accessibility in the study is 2011, meaning that the two examined titles that launched that year only follow 30% of the guidelines; whereas accessibility peaked in 2020 where 70% of guidelines are present in the seven reviewed games released that year. Moreover, the level of accessibility remained steadily low (between 30% and 40%) from the year 2010 to 2016 even though most of the games of this study released during those years. On the contrary, the period from 2017 to April 2022 (with fewer reviewed titles launched during this time) has a better level of accessibility (ranging from 50% to 70%). To illustrate, the variation in 2014 shows more games released but less accessible compared to the year 2020 with fewer games and more accessibility. These observations suggest that accessibility in video games is on the rise. Therefore, the developers and publishers of this genre are including more accessibility options and features in their titles and innovating and creating tools along with game mechanics to help persons with disabilities fully enjoy and play as anyone else.

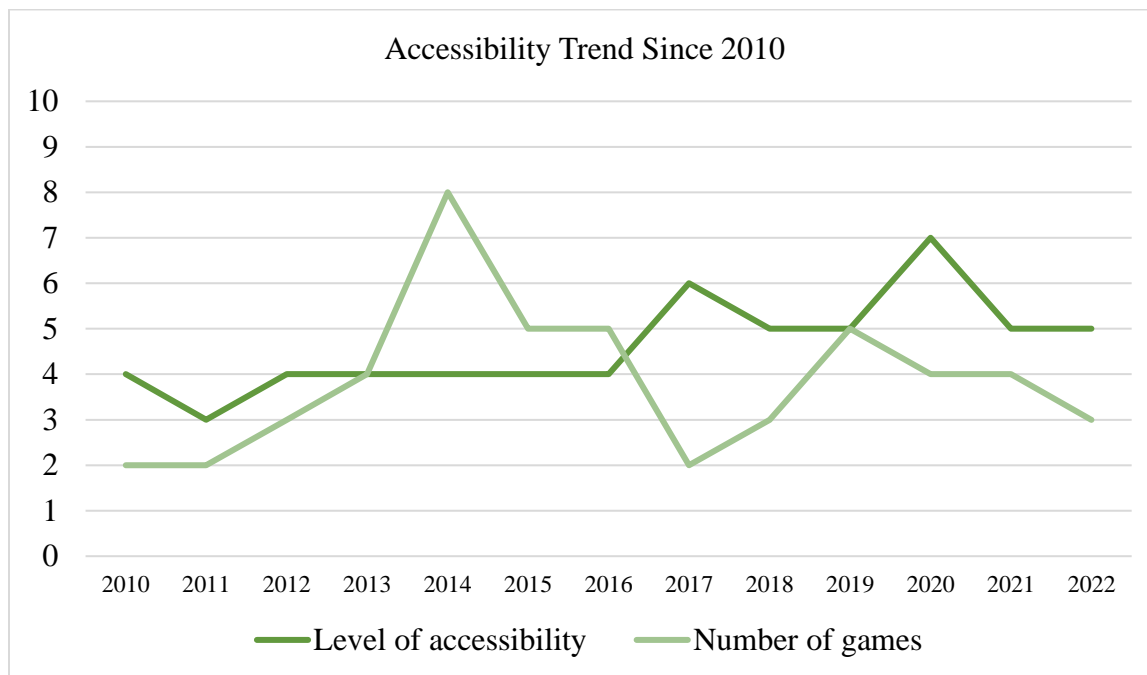


Figure 35. Accessibility trend displaying the level of accessibility and the number of studies games per year since 2010.

Results Summary

The GAG is the only set of guidelines considered in this study that makes a distinction between accessibility recommendations by dividing them into basic, medium, and advanced levels. This division provides an additional measure of the level of accessibility because the results can be presented in three categories. For this reason, only the options contemplated in the GAG could be counted for the calculation of the average in the final results. Nonetheless, several options and features not included in the GAG, but analyzed in this study, could have impacted these percentages. The accessibility options and features that are not present in the GAG, and thus are not categorized in basic, medium, or advanced levels are the following: screen magnification, fixed save points, dedicated accessibility menu, pause gameplay, subtitles are adjustable at any time, screen flashes, change repeated taps, and vibration.

The average results of each Game Accessibility Guideline per category (general, auditory, visual, motor, cognitive, and speech) show that games comply with most basic guidelines (73%, see table 8), almost half follow intermediate recommendations (43%), and only a few titles include advanced ones (14%). In general, the average percentage of games that have accessibility guidelines is 44%. On the one hand, this investigation proves that PC action/adventure titles are not very accessible according to the Game Accessibility Guidelines. On the other hand, and in agreement with the trend above, these games have been becoming more accessible since 2010.

Results separated by GAG category			
	Basic	Intermediate	Advanced
Average percentage of games that have a guideline by category	73%	43%	14%
Average percentage of games that have accessibility guidelines	44%		

Table 8. Summary of average percentages of Game Accessibility Guidelines separated by category and the overall result.

Conclusions

Action/adventure games are not very accessible, but developers have been improving thanks to the inclusion of new features, although, at the expense of other options. Also, this genre has accessibility settings that are becoming increasingly popular, as they are present in the majority of games (strengths) and are useful not only for gamers with disabilities, but also for users under situational limitations. Contrastingly, other accessibility options are missing. This represents weaknesses and points of improvement. The main conclusion of this research is that PC action/adventure games are not very accessible because the average percentage of games that have Game Accessibility Guidelines is 44%. However, the video game industry is showing improvement as these games have been becoming more accessible year after year. Furthermore, game developers have added options that enhance accessibility and stopped supporting several others possibly because of budget, priorities on which features to implement, or lack of accessible design from the beginning of the project. In the end, these decisions to cut off or not support or develop a feature or option anymore hurt accessibility. The new characteristics that developers have added include grouping accessibility options in a dedicated menu, new difficulty options such as custom difficulty and the possibility to bypass difficult parts of the game or simplify gameplay elements. Subtitle customization options are also among the more recent features thanks to the addition of settings for subtitle size, colors, and font. Other features that are fairly recent among the games of the study are screen narrator, simple controls, speech-to-text, and text-to-speech. Their newness may explain why these options received poor results. Nevertheless, text chat is an option that many game developers have excluded. Video games are also a space for innovation and inclusion as proved by the implementation of automatic movement, a feature that greatly improves accessibility specially for gamers with motor disabilities.

Among the accessibility features that action/adventure games share in common in PC are subtitles, volume controls, all areas of the game are accessible with the same input, support for more than one input device, tutorials, no multiple menu navigation to start a game, presence of help tips and reminders of objectives and controls during gameplay, and no speech input requirements. On the contrary, other options are completely absent in this genre such as adaptive difficulty, mono/stereo toggle, audio description, adjustable interface font, game speed, macro system, the ability to perform actions while the game is paused, and the possibility to select to

play only with people who have voice chat enabled or disabled exclusively. Hopefully, title releases will start to include audio description in-game; nevertheless, providing audio described trailers is a major first step towards progress. In conclusion, the addition of more options that players are able to customize can increase the level of accessibility.

Furthermore, the PC platform with the Windows 10 operative system offers accessibility solutions in the form of tools that games are missing natively and allows users to modify and hack PC games to make them more accessible. Windows 10 offers accessibility tools such as screen narration, colorblind filters, screen magnification, and monoaural sound, features that most games in this research have a lack of. In addition, the user can install programs to set up macro systems for keypresses or install modifications (in gaming, often referred as mods or the act of modding a game) for games designed by other players; for example, difficulty mods for titles such as Elden Ring or Sekiro: Shadows Die Twice (the latter developed by Tender Box and aptly named Sekiro The Easy) make these releases easy to play by modifying a range of game parameters such as damage output and defense. Lastly, PC games are hackable, which allows the user to customize options and add features that are not natively present in games such as enabling windowed mode or adding fan translations. The PC platform offers a wide range of accessibility options and, if needed, allows users to add or enable these options themselves.

Moreover, action/adventure games have strengths and weaknesses related to accessibility. With regard to disabilities, all basic and most intermediate cognitive guidelines are present, therefore, these games would be better suited for gamers with cognitive difficulties. Moreover, most games follow basic guidelines in the rest of the categories except for visual guidelines. With reference to weaknesses, players with auditory, visual, motor, and speech difficulties face many more obstacles as the action/adventure genre falls short with the guidelines designed for these types of disabilities. In relation to the GAG, basic visual recommendations and most intermediate and advanced guidelines also represent areas of improvement (e.g., colorblind filters, game speed, and audio description). More specifically, game developers can greatly improve accessibility if they include options that are less common such as adjustable game speed, input delay, and eye tracking.

A significant conclusion of this research is that video games have been becoming more accessible since 2010. This investigation revealed that the level of accessibility stayed the same

in the years with more analyzed games and showed improvement in the years with fewer examined games. This fact might be due to developers (such as Ubisoft) releasing yearly iterations of the same franchise (Far Cry or Assassin's Creed) and new intellectual properties with more accessibility features.

Further Research

Subtitle quality in video games, with special regard to subtitles for the deaf and hard of hearing, and accessibility in other platforms such as PlayStation, Xbox, and VR, as well as in other game genres were not part of this study and may be the subject of further research. An evaluation of subtitle reading speed, segmentation, labeling of sound descriptions, and other guidelines can help elucidate the state of subtitle quality in action/adventure games. Accessibility assessments per company, platform, and genre can also reveal which gaming enterprises and platforms are improving in this area, which companies and platforms provide more accessibility support, and which genres are best suited for people with specific accessibility needs. Exploring these areas could reveal the level of accessibility of developers and publishers, their strengths and weaknesses in relation to accessibility, if they involve people with disabilities in the accessibility testing phase, or if they have a team dedicated to accessibility.

Games available on other platforms such as PlayStation and Xbox (the former a platform with critically acclaimed accessible games such as *The Last of Us Part II*, and the latter a company that designed the Xbox Accessibility Guidelines and strives for accessibility) were not part of the selected sample of the study. Including these titles in further research would help demonstrate the level of accessibility in consoles. Researchers could elaborate case studies of accessibility in games developed by a specific publisher such as Ubisoft, Microsoft, Sony, or Electronic Arts, or case studies by platform and evaluate accessibility in PS5 and Xbox consoles or in the games available on those systems. Lastly, virtual reality (VR) is another space in gaming that deserves attention. Virtual reality games should offer players with disabilities the opportunity to enjoy as anyone else because VR games are video games too, and if they should be accessible, according to video game accessibility guidelines and legislation, then, VR games have to be accessible as well. Efforts to measure the level of accessibility in VR would be substantial to define the strengths and weaknesses in this space and help define guidelines for VR and direct the focus of VR developers towards making accessible VR releases.

Other areas of study could focus on finding out if games with missing colorblind filters are portraying information determined by color or not. This would allow to discover if excluding colorblind filters is really not necessary because players who cannot differentiate between colors would not be missing vital information. The present study only concentrated on checking if the defined accessibility features are present in-game but did not analyze if the information portrayed only by color is essential. With regard to localization, not all contents of a game are localized entirely (e.g., the UI of a game can be localized, but not the audio, or sometimes only the subtitles are translated). The object of this research was to verify which languages were present, but not how much content of the game was localized; therefore, this could be a future line of investigation. More research could also involve testing with people the accessibility features already present in games to confirm their actual usefulness.

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Appendices

Appendix 1: Glossary of Examined Accessibility Options and Features

accessibility chat. A visual communication method for multiplayer games that is based on symbols, character gestures, or preset messages that players can send during gameplay.

accessible input of user interface. A feature that allows the player to control gameplay and navigate the user interface with the same input device.

adaptive difficulty. A type of difficulty feature where the game automatically detects player performance and adjusts difficulty accordingly or identifies player shortcomings and suggests difficulty changes.

adjustable interface text. A set of options that allows the player to customize the interface text such as color, size, and font.

aim assist. A feature that helps the player with aiming where the game automatically snaps to a target. When aim assist is active, the player is not required to be as accurate with the controller depending on the intensity of assistance.

audio description. An accessibility service where environments, actions, and characters are described with voice overs during beats in the soundtrack of an audiovisual product.

autosave. A method to save player progress automatically when a condition in-game is met such as collecting items, entering specific areas, or exiting the game. With autosave, the games saves all player progress and protects losing progression due to an unexpected crash or to the player exiting the game without saving.

blood and gore. A toggle to turn off depictions of blood or gore in-game.

brightness. A display adjustment option that allows the user to adjust how bright the displayed image is.

bypass gameplay. A difficulty option that allows the player to skip a part of the game or simplifies a game mechanic.

camera shakes. An option to enable or disable camera sway or shakes in-game. This is an effect that is triggered when the player moves their in-game character or is impacted by an enemy hit or bullet. This effect makes the camera shake to increase immersion.

change holds to presses. A toggle to allow the player to change button holds to presses. This option is useful when the player prefers to toggle crouching, running, or aiming instead of constantly holding those buttons to perform such actions.

change repeated taps to holds. An option to change repeated button tapping to holds. Therefore, instead of repeatedly tapping a button to perform an action, the player can hold the button.

change repeated taps to single tap. An option to change repeated button tapping to a single tap. Therefore, instead of repeatedly tapping a button to perform an action, the player can tap the button once to perform the event.

color customization of the cursor. An option that allows the user to customize the color of the cursor.

color customization of the game map. An option that allows the user to customize the colors of the game map. Elements of the game map such as waypoints, objective areas, and dangerous zones are often portrayed in game by means of colors.

color customization of the game menu. An option that allows the user to customize the colors of the game menu.

color customization of the heads-up display (HUD). An option that allows the user to customize the colors of the heads-up (HUD). Elements of the HUD include waypoints, objective markers, health and shield bars, equipped items, and reticle and these are often portrayed in game by means of colors.

color customization of the reticle. An option that allows the user to customize the color of the reticle. The reticle is a dot or graphic element that appears in the center of the screen to help the player center their aim.

color of subtitles. An option that allows the user to customize the color coding of the subtitles.

colorblind filters. An option that allows the user to customize colors using filters. The user can choose from a free range of colors or from preset filters such as deuteranopia, tritanopia, and protanopia.

colorblind mode. A preset mode that changes color without a specification of colorblindness type.

contextual in-game help and tips. Messages or prompts that show on-screen during gameplay that provide advice to the player on how to interact with a certain element or mechanic of the game and appears not only at the beginning in the tutorial phase, but constantly throughout the game depending on the context of the player.

contrast. An image adjustment option that allows the player to adjust the level of contrast of the displayed image.

controller customization. A feature that allows the player to reassign the button and stick configuration of the controller.

custom difficulty. A difficulty setting that the player can customize which is more detailed than preset difficulty options because the level of customization is higher as the player can modify more aspects of gameplay separately and not as a whole. For example, players can modify the level of combat, stealth, and exploration independently and choose to play with easier combat but harder exploration.

dedicated accessibility menu. A menu that gathers all accessibility options in one place. This menu may appear the first time a player boots a game, after gameplay, or in the main game menu.

deuteranopia. A choice of color filter that helps people who have this type of colorblindness.

dialogue. A type of volume control that allows the user to adjust the volume level of dialogue in the game.

difficulty is adjustable at any time. A feature that allows the player to change the level of difficulty at any point after starting the game.

difficulty. Options that allow the player to choose how hard the gaming experience is. Developers can increase or reduce difficulty by toughening up the enemies, removing in-game tips or the HUD, and modifying player health, inventory capacity, and item efficiency, among others.

drive and shoot aim assist. A feature that helps the player with aiming and shooting when driving a vehicle, riding a mount, or controlling any kind of means of transportation. With this type of assistance, the game automatically snaps to a target when the player is driving to assist with aiming, shooting, and driving at the same time. When aim assist is active, the player is not required to be as accurate with the controller depending on the intensity of assistance and eases multitasking when driving and shooting.

eye tracking. Hardware and software that a player can use to give commands using their eye gaze.

fixed control scheme. A preset layout of buttons and sticks on a controller or keys and buttons on keyboard and mouse. This feature allows to partially customize controllers or keyboard and mouse.

fixed save points. A method to save player progress only when a condition is met. The main difference with autosave is the fact that the game is saved only at certain places or under specific conditions (often called checkpoints), or only when the player exits the game. Another difference with autosave is that the game does not save automatically when the player picks up an important item or collectible. With fixed save points, the player may advance in the game, collect items, or beat bosses, but if a checkpoint is not reached, then, the game is not saved.

full controller customization. A feature that allows the player to fully reassign the button and stick layout when playing with a controller. This means that the user can customize every button and stick direction of the controller.

full keyboard and mouse rebinding. A feature that allows the player to fully customize keys and buttons when playing with a mouse and keyboard. This means that the user can reassign every key and mouse button.

full stick customization. A feature that allows the player to fully reassign the configuration of the controller sticks.

game speed. An option that allows a player to adjust the speed of the game engine. This feature is specially designed to make actions occur in slow motion (also called bullet-time).

gamma. A display adjustment option that allows the user to change the gamma correction of the displayed image.

interactive tutorials. A form of in-game guide that requires player interaction to show how to play the game, how to perform actions or moves, and how the mechanics of the game work. In interactive tutorials, the game requires the player press a key or button or perform the command being taught to advance.

interface font. An option that allows the player to customize the interface font.

interface size. An option that allows the player to customize the size of the interface.

interface text color. An option that allows the player to customize the color of the interface text.

keyboard and mouse rebinding. A feature that allows the player to reassign keys or buttons when playing with a mouse and keyboard.

labels. An SDH feature used to describe sounds only produced by speech (laughs, screams, coughs, etc.).

macro system. A feature that allows users to program one key or button that, when pressed, triggers several combinations of keystrokes or programmed actions to assist with repetitive tasks.

manual save. A method that allows the player to save progress manually. With manual save, the player can save when and wherever they want to and not when a condition in-game is met.

master/all. A type of volume control that allows the user to adjust the volume level of the game as a whole.

monochromacy. A choice of color filter that helps people who cannot distinguish between colors (see in shades of gray).

multiple input device support. A feature that allows the player to control the game with more than one input device. This means that the game is compatible with controllers, mouse and keyboard, among others.

music. A type of volume control that allows the user to adjust the volume level of music in the game.

no multiple level of menu navigation. A feature that allows the user to start a game without having to navigate through several menus or settings first.

online play with or without voice chat. An option that allows players to choose to play online exclusively with others who have voice chat enabled or disabled. If toggled, the player will only get matched with other players who have the same preference.

partial controller customization. A feature that allows the player to partially adjust the button and stick layout when playing with a controller. This means that the user cannot customize every button and stick direction of the controller or may only be able to customize the sticks or buttons of the controller and not both.

pause gameplay. A feature that allows the player to stop gameplay. When the game is paused, all activities, actions, or movements in-game cease until the player resumes the game.

post acceptance delay between inputs. A feature that allows the player to delay input recognition by a specific number of milliseconds. This tool protects against unintentional inputs due to missed presses or stick flicks.

precise timing circumvention. A feature that allows the user to play without requiring them to perform precise timed actions in-game. This option provides alternative actions or mechanisms to skip gameplay that requires precision (allows the player to perform actions while the game is paused).

preset difficulty. Options preestablished by the developers that allow the player to choose how hard the gaming experience is. Often, these options are easy, normal, and hard.

preset stick customization. A feature that allows the player to reassign the configuration of the controller sticks with preset combinations (partial configuration or the sticks).

protanopia. A choice of color filter that helps people who have this type of colorblindness.

qte autocomplete. A method to successfully complete a QTE challenge by automating button pressing or holding. With this feature, the player can successfully pass a QTE challenge without button interaction.

qte button holding. A method to successfully complete a QTE challenge by making the player hold a button.

qte button pressing. A method to successfully complete a QTE challenge by making the player press a button repeatedly.

qte single button. A method to successfully complete a QTE challenge by making the player press a single button once.

quick-time events (QTE). A gameplay situation that requires the player to press a button quickly.

reminder of controls. Messages or prompts that appear on-screen during gameplay or information of key and button assignments accessed via the game menu that help the player remember how to control the game.

reminder of gameplay objectives. Messages, prompts, waypoints, or icons that appear on-screen during gameplay or textual information of the objectives accessed via a game menu that help the player remember what the objectives of the game are.

save progress. The method a game uses to save player progress such as autosave, manual save, or fixed save points.

screen flashes toggle. An option that allows the user to enable or disable screen effects such as screen flashes and other effects that distort the displayed image under certain conditions.

screen magnifier. A tool that functions as a magnifying glass of the screen.

screen narration during gameplay. A feature where a narrator reads aloud the text appearing during gameplay.

screen narration in menu. A feature where a narrator reads aloud the text appearing only in the menu of the game.

screen narration of text. A feature where a narrator reads aloud the text appearing in other game menus apart from the main menu.

screen narration. A feature where a narrator reads aloud the text appearing in the game.

simple controls. An easy control design or simpler alternatives to control in-game actions.

sound effect descriptions. An SDH feature used to only describe sound effects such as captions for music and other relevant noises.

sound effects. A type of volume control that allows the user to adjust the volume level of sound effects in the game.

speaker color: An option that color codes subtitles belonging to different characters to help distinguish who is talking.

speaker indicator. An SDH feature that, in the video games setting, indicates the name of who is speaking at the beginning of the subtitle.

speech input. A feature that allows the player to control the program with their speech via voice commands.

speech-to-text. A feature that displays partner player speech into text on-screen for online communication. Useful for players who cannot hear.

stereo/monoaural toggle. An option that allows the user to switch all audio to one position. Useful for players who have hearing in one ear only or are only using one earphone.

stick customization. A feature that allows the player to reassign the configuration of the controller sticks.

subtitle background. An option that allows the user to enable a letterbox behind the subtitles to help with legibility. This option may appear in the form of preset background opacities or a slider.

subtitle is adjustable at any time. A feature that allows the player to enable or disable subtitles at any time during gameplay.

subtitle size. An option that allows the user to adjust the size of subtitles. This option may appear in the form of preset sizes to choose from or a slider.

subtitle width. An option that allows the user to adjust the spacing between subtitles to assist with legibility. This option may appear in the form of preset distances to choose from or a slider.

subtitles for the deaf and hard of hearing. A service that displays information about important sound events (using captions on-screen and often called sound subtitles) near the player such as explosions, vehicle engine sounds, and weapon fire. In video games, sound subtitles can also be directional subtitles that point the direction of sounds using arrows.

subtitles. A service that displays auditory information on-screen.

surround sound. An immersive feature in video games that makes sounds become directional. For example, vehicles or explosions occurring on the left side of the player will be heard mostly from the left earphone.

text chat. A method of communication with other players in-game via text messages that appear on the screen.

text tutorials. A form of in-game guide that explains with text how to play the game, how to perform actions or moves, and how the mechanics of the game work.

text-to-speech. A feature that converts text into speech for online communication. Useful for players who cannot read text messages.

tritanopia. A choice of color filter that helps people who have this type of colorblindness.

tutorials accessible at any time. The user can access in-game guides at any time when playing the game.

tutorials. In-game guides that explain how to play the game and how the mechanics of the game work.

vibration toggle. An option to turn on or off controller vibration (also called rumble or haptic feedback).

video tutorials. A form of in-game guide that shows with a video how to play the game, how to perform actions or moves, and how the mechanics of the game work.

voice chat. A method of communication with other players in-game via voice.

volume controls. Options that allow the user to adjust separately how loud sounds, music, special effects, and dialogue are.

windowed mode. A feature that allows the user to play a game in a window on the screen. This option is contrary to fullscreen mode, where the whole screen is occupied by the program. In windowed mode, a user running a game and other programs at the same time is able to see and interact with them on the same screen space.

Appendix 2: List of Examined Games

List of Analyzed Games	
Title	Release Year
Assassin's Creed 2	2010
Batman: Arkham Asylum Game of the Year Edition	2010
Assassin's Creed Brotherhood	2011
Assassin's Creed Revelations	2011
Far Cry 3	2012
Tom Clancy's Ghost Recon Future Soldier	2012
Batman: Arkham City Game of the Year Edition	2012
Far Cry 3: Blood Dragon	2013
Assassin's Creed Black Flag	2013
Tomb Raider	2013
Assassin's Creed Origins	2013
Far Cry 4	2014
Watch Dogs	2014
Assassin's Creed Freedom Cry	2014
Assassin's Creed Rogue	2014
Assassin's Creed Unity	2014
Batman Origins: Blackgate Deluxe Edition	2014
Metro 2033 Redux	2014
Metro: Last Light Redux	2014
Grand Theft Auto V	2015
Assassin's Creed Syndicate	2015
Assassin's Creed Chronicles China	2015
Rise of the Tomb Raider	2015
Batman: Arkham Knight	2015
Far Cry Primal	2016
Watch Dogs 2	2016
Assassin's Creed Chronicles India	2016
Assassin's Creed Chronicles Russia	2016
Dying Light: The Following - Enhanced Edition	2016
Assassin's Creed Origins	2017

Tom Clancy's Ghost Recon Wildlands	2017
Far Cry 5	2018
Assassin's Creed Odyssey	2018
Shadow of the Tomb Raider: Definitive Edition	2018
Red Dead Redemption 2	2019
Far Cry New Dawn	2019
Assassin's Creed III Remastered	2019
Assassin's Creed Liberation Remastered	2019
Tom Clancy's Ghost Recon Breakpoint	2019
Watch Dogs Legion	2020
Assassin's Creed Valhalla	2020
Immortals Fenyx Rising	2020
Horizon: Zero Dawn	2020
The Pathless	2021
Far Cry 6	2021
Days Gone	2021
Metro Exodus Enhanced Edition	2021
God of War	2022
LEGO Star Wars: The Skywalker Saga	2022
Dying Light 2 Stay Human	2022

Table 9. Games examined in this research listed by release year from oldest to newest.