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Current Perceptions of Virtual Reality Technology

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Abstract: User experience is a key predictor of future use of goods and services. The presented study collected a combination of qualitative and quantitative data from both experienced users and novices about their perceptions of virtual reality (VR) equipment, any concerns surrounding the data collected by the equipment, and facets that needed to be taken into consideration for future developments. The purpose of this research was to understand the current user experience of VR and ways in which it can be improved. The findings indicated that the majority of people have used VR, albeit infrequently, and that the most common use for it was for entertainment purposes. The most important characteristics of VR systems were judged to be the available content and price. While it was reported to be enjoyable to use, the ways in which it was suggested to be improved were through a reduction in size and weight of the headsets, and incorporating wireless capabilities. Concerns about the use of VR were the potential for sickness, discomfort, and eye strain, the disconnect from the real world and the subsequent risks that this poses, as well as the use and privacy of user data. The findings from this research can be used as a stepping stone toward the advancement of VR technologies.

Keywords: virtual reality; user experience; technology acceptance; HCI

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1. Introduction

1.1. Virtual Presence and Immersion

Virtual reality (VR) provides many potential advantages over other display technologies through its ability to create immersive experiences for users. A key goal of VR is the creation of *presence*, defined as the phenomenological sense that one really is in the virtual environment [1]. This sense of 'being there' includes not only spatial presence (the experience of being physically present in the virtual environment), but also the dimensions of social presence, realism, and engagement [2]. Social presence is the feeling of being present with real people [3]; realism refers to the extent to which the virtual experience corresponds to that of the equivalent physical environment [4,5]; while engagement requires a strong experiential connection with the elements of the virtual environment [4]. Presence generally is a concept that has been used to explain the effectiveness of VR [6].

From a technical perspective, a number of considerations determine the degree of presence and immersion that can be achieved in VR [7–9]. A limited field of view [10,11], tracking lag [12,13], limitations in the resolution, dynamic range, and rendering accuracy of the graphics [14], as well as limited interaction with the environment [15,16] can all impact the ability of users to become immersed in the virtual environment or can limit their sense of presence. In addition, these factors can also influence the perception of the 3D layout of the environment, including the perception of distance [17,18] and depth [19,20].

As these properties are important contributing factors to successful immersion and presence within virtual environments, VR devices strive to achieve perceptual realism and accuracy. Ensuring there is a wide field of view, providing a substantial binocular overlap; an enclosed headset to ensure immersion in the virtual environment; making sure the user cannot engage visually with the physical world; having close to real-time tracking of the user's position; and interaction with the virtual environment. These and other technological advances are all ways that manufacturers of headsets have continuously improved the perceptual experience of VR, towards the ultimate goal of a perceptual experience that cannot be distinguished from reality [21–23].

Beyond these technical considerations, the importance of focussing on user experience when defining and evaluating a VR experience has been emphasised [24]. Here, central roles are played by *vividness* and *interactivity* in creating an immersive experience. Overall, the properties of perceptual immersion in a virtual environment and the reactivity of this perceptual experience to the user's movement and behaviour are critical in creating the sense of presence that sets the experience of VR apart from the experience of viewing other types of displays.

This ability of VR devices to create an experience that is both immersive for the user and responsive to their interactions with the virtual environment presents many potential applications for the technology across multiple domains. However, to date, the advertising of VR has tended to be targeted primarily at the gaming market [25–27]. In fact, the ambition for this technology is that, like smartphones, it will become ubiquitous in all our personal and professional social interactions [28].

Indeed, applications of VR are widespread, encompassing education [29–32], training [33–38], healthcare and rehabilitation [34,39,40], well-being [41–44], heritage and museums [45–49], theatre [50–52], cinema [53,54], journalism [55–57], non-fiction documentaries [58,59], teleoperation [60,61], product design [35,62,63], architecture [64,65], and social and business meetings [66].

If this breadth of applications is to be realised, it is important to understand how VR technology is designed for and perceived by current consumers as well as potential future users.

1.2. Acceptance Models for Behaviour

The ambition to integrate VR and related technologies, such as augmented and mixed reality, into daily life depends not just on the creation of high-quality hardware and experiences but also on the successful adoption of the technology by the intended users. Here we discuss models that aim to predict such behaviour.

The Theory of Reasoned Action (TRA) [67] was developed to understand the relationship between an individual's attitude toward a certain behaviour, their behavioural intentions, and their actions, and can be applied to the use of technology such as VR. While the separation of behavioural intentions from actually carrying out behaviour is important in this model, it proposes that the intention to engage in a specified behaviour is the best predictor of whether it actually occurs. These behavioural intentions are influenced by both societal norms and the person's own attitudes, as illustrated in Figure 1a.

The Technology Acceptance Model (TAM) [68] was developed from the TRA as a model of how people accept and use technology. It proposes that the perceived usefulness and ease of use of a technology are the two most important predictors of whether it will be used (Figure 1b). *Perceived usefulness* is defined as how much the individual believes that using the piece of technology would enhance their performance, and *perceived ease of use* is the amount the individual thinks that using the technology would be effortless. A meta-analysis of applications of the TAM found perceived usefulness to be the strongest predictor of intention to use [69].

Despite the success of the TAM [70–75], it has been argued that such acceptance models may lack some important variables or are not fully applicable in all circumstances [76]. For example, the extent to which an individual is actually able to engage in a behaviour due to resources and opportunities is not taken into consideration in either the TAM or the TRA. In particular, for technology with a significant financial cost, the perceived ability to accommodate this cost should be considered. Thus, the Theory of Planned Behaviour (TPB) [77] may serve as a more comprehensive theory than the TAM, which is shown in Figure 1c. This is an extension of TRA with many of the same predictors, such as attitude, norms, and intention. Critically, however, perceived control over one's behaviour is added to the model.

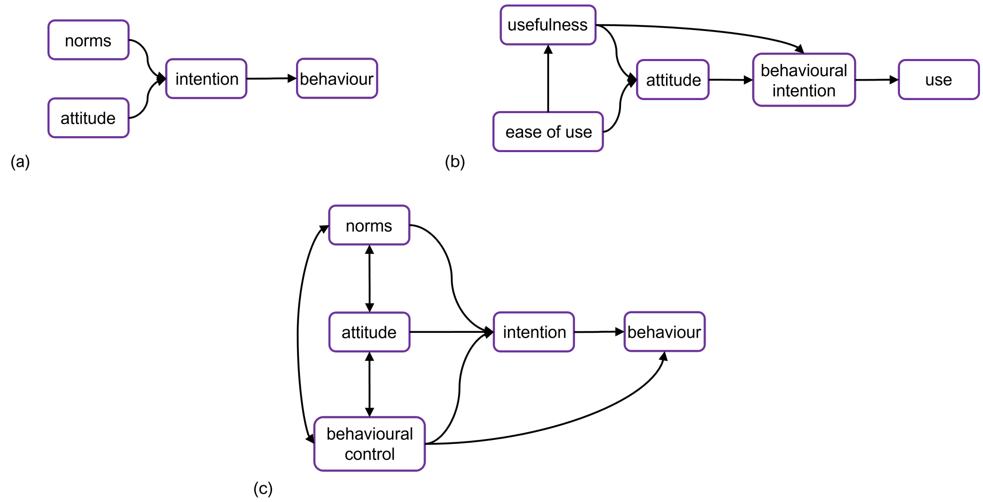

Figure 1. Acceptance models for behaviour: (**a**) The Theory of Reasoned Action [67]; (**b**) The Technology Acceptance Model [68]; (**c**) The Theory of Planned Behaviour [77].

The Virtual Reality Hardware Acceptance Model (VR-HAM, Figure 2) is an adaptation of the TAM developed specifically for VR [78]. This model adds the extra objective variables of age and price, as well as the subjective variables of curiosity, usefulness, enjoyment, and ease of use. In this model, perceived enjoyment was found to be the most powerful predictor of the acceptance of VR, consistent with research implementing this model in the case of handheld devices [71].

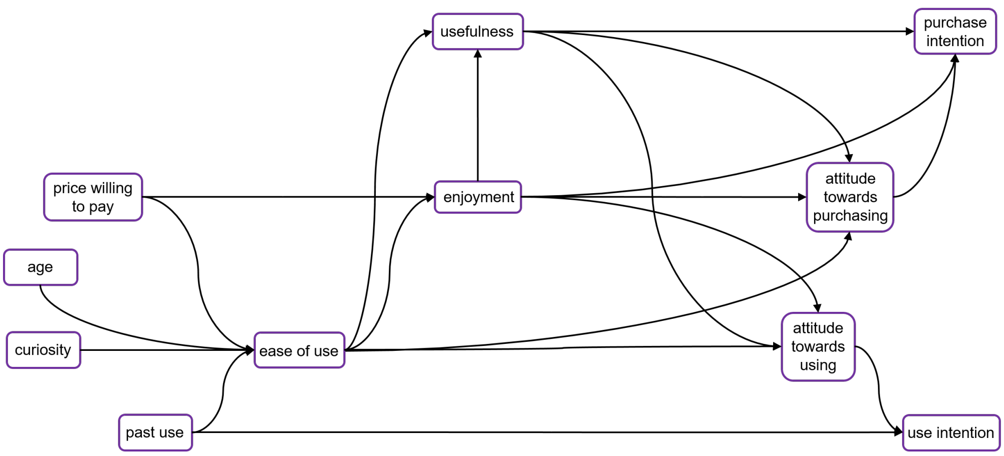

Figure 2. The Virtual Reality Hardware Acceptance Model [78].

Similarly, other variations of the TAM have been used to predict uptake. In a survey of 350 participants, a modified TAM was used with the goal of understanding the acceptance of VR in South Korea [79]. Perceived enjoyment, social interactions, and the strength of social ties were added to the model; the findings showed that social interactions and the strength of social ties increased perceived enjoyment. Further to this, perceived enjoyment had a more significant effect on intention to use than did perceived usefulness. This is an important point of difference from the TAM, for which perceived usefulness is the main predictor of adoption and perceived enjoyment is not considered.

Further modifications of the original TAM include perceived cost as an additional factor and have also been applied to understand the intentions of participants with prior experience with VR and/or an expressed interest in using the technology [80]. In this study, only perceived usefulness significantly predicted intentions to use VR. This suggests that there are variables such as one's background knowledge, hobbies, interests, and technological requirements that are key factors for predicting future behaviour, and that the important factors for the acceptance and adoption of VR will differ across different groups.

Another research study [81] noted that many of the acceptance models also do not include subjective factors such as emotions, aesthetic appeal, and hedonic qualities; this is important as there is evidence that these factors influence people's intention to use the technology [82–84], and for the importance of enjoyment as a predictor of VR use [78].

VR in education was also explored [85]: the attitudes of university students and lecturers were gathered and analysed in relation to the TAM. The survey explored viewpoints on general knowledge of the equipment, VR's ease of use, and whether there was any desire to incorporate it into teaching. The study found that the TAM is a reliable method of explaining attitudes towards VR in this context.

These results also show that there is a strong connection between the factors influencing the adoption of VR and those for mobile devices. This is especially salient when we also consider the case of augmented reality (AR). AR, and in particular head-mounted AR, contains many of the core features of VR, notably that it creates a convincing and responsive experience of interacting with virtual objects. AR differs from VR, however, in that it is a wearable technology that is used while interacting with and experiencing the physical environment. Studies of the drivers of and barriers to the adoption of AR have identified a number of key considerations. In one study, the most important factors influencing attitudes towards and intentions to use AR were its functional benefits, the user's attitudes towards the company providing the device, the user's technological innovativeness, and social norms [86]. In this case, social norms refer to the user's beliefs about other people's expectations that they would adopt the technology.

The importance of the technology brand relates to the ubiquitous nature of AR and its ability to both gather and present personal and personalised data. In another study [87], this was identified in terms of the potential for the misuse of the technology, for example through pervasive and covert capture of audio and video, surveillance, data distribution, and involuntary exposure to advertisements. It is thus important to users that there is an appropriate degree of trust in how the data collected when using AR will be used and the extent to which the technology might be used to influence the user's own feelings and behaviours [88,89].

Other important considerations in the adoption of AR smart glasses include usability factors such as the appearance, weight, and battery life of the headset [90], value for money, and possible exposure to risks such as invasion of privacy, injury, and theft [91].

With each new and updated model, more predictors are added and modified. This reflects the complexity of predicting behaviour and further highlights the need for user experience research such as the current study.

1.3. Analysing Attitudinal Data

Behaviour modelling can be achieved through the analysis of attitudinal data, which can be obtained through primary or secondary sources. In this section, a number of ways such data has been analysed will be discussed.

A content review of 321,746 tweets related to the keyword "metaverse", posted in a 1.5 year period, was analysed [92] with the goal of developing an understanding of the opinions towards the security and privacy of users within the Metaverse. After formatting the data, quantitative and qualitative analyses were conducted. It was revealed that 538 tweets included the keyword 'privacy'. Although the current research study is not surrounding the Metaverse, the theme of privacy is likely to appear given the potential use of VR in the metaverse. Sentiment analysis showed that 59% of the users were positive and 33% were neutral about the security of the Metaverse. In the current study, a similar procedure will be undertaken to assess attitudes towards VR; however, the data will be primary rather than secondary.

These authors conducted a similar analysis on tweets pertaining to the opinions held by users of the Metaverse Marketplace [93]. Here, tweets were analysed using a lexicon-based technique that assigned sentiment scores to individual words. This technique allows for quick analysis of large datasets and provides scores that can be quantitatively analysed in terms of both frequency and sentiment. Sentiment analysis will therefore be used in the presented study.

A related study, using a more quantitative approach, was conducted on the perceptions towards marketing in the Metaverse [94]. Partial least squares structural equation modelling and an artificial neural network were used to analyse survey responses, specifically looking at whether perceived social benefits and trust lead to brand loyalty. It was revealed that perceived social benefit and trust had significant mediating effects on attitude toward the product, loyalty to the seller, and purchase intention. These are important factors for manufacturers to take into consideration; however, the goal of the current research is more exploratory in nature, to determine the experiences and attitudes toward the technology more generally.

An experiment that gathered participants' views on the use of 3D video tours in travel destination websites used a different method of analysing the collected data [95]. Here, participants browsed an allocated travel website, and navigated through the 3D video tour. Following this, a series of Likert questions were administered, where ratings from 1 to 7 were given on topics such as aesthetics, informativeness, and novelty. This method of collecting levels of agreement is useful, especially when the prompts are simple. For this reason, the presented study will include such methods; however, instead of analysing using the mean response and skew direction, the mode responses and Wilcoxon signed-rank tests will be used to determine the direction and strength.

Other relevant studies have attempted to further our understanding of why VR has or has not been adopted in different domains. An important application of VR is the realm of mental health [96]; one such study gathered attitudinal data on participants after they had witnessed VR therapy [97]. Much like in the previous studies, data were formatted before analysis, positive and negative sentiments were calculated, and Likert questions were ranked. The findings suggested there is a willingness to try VR therapy, and with the rise in uptake of VR equipment, it is predicted that positive attitudes towards virtual therapy will also increase.

A proof-of-concept study explored the attitudes that a selection of university students and teachers had about VR in education [98]. Although small, the quantitative design was able to gather insights through a series of closed questions. Responses were given toward the associated costs of VR equipment (implementation, space, and maintenance) and that, although it may be beneficial in a university setting, the costs for the consumer are extensive. Numerous studies on VR equipment have revealed cost concerns, which is a key component of predicting behaviour. When technological advancements are so rapid, there is no guarantee that what is purchased will not become obsolete in the near future.

1.4. Current Research Questions

The overall goal of the current study was to understand current attitudes towards VR and related technologies, how these correspond to its adoption, and views on its applications beyond gaming. It is necessary to understand consumer attitudes towards such technology and to keep up with attitudes as new iterations of the devices are rolled out, for both manufacturers and researchers. By understanding consumers' perceptions, preferences, and adoption barriers, companies can make informed decisions about product development, marketing strategies, and market positioning. At the same time, research such as this provides insights into the way individuals act on their perceptions of equipment and enhances the literature on technology acceptance models.

To achieve these goals, a novel questionnaire was developed that included both forced-choice and free-text questions. Commonalities between individuals who did and did not (at the time of answering) choose to use VR were pinpointed, and their explanations as to why were also assessed. This method was used to understand whether the various acceptance models relating to VR, such as TAM and VR-HAM, take the most important factors into consideration now that the technology is more widely available and more people may have some experience with its use compared to when these models were created.

Who uses VR? The first section of questions collected basic demographic information from our participants. The second section focussed on physiological characteristics, such as potential visual and auditory impairments and susceptibility to motion sickness, that might affect a potential user's ability to benefit from VR. Questions on the participant's hobbies and interests were also included to understand the relevance of VR in these fields. No demographic differences were expected between users and non-users. Links between the degree of enjoyment and engagement with other types of gaming and VR usage were expected, as well as a negative relationship between VR usage and the propensity for motion sickness and the presence of existing visual or auditory impairments. Perceived usability was also expected to have an impact on the enjoyment of VR.

Why and how do people use VR? Questions on the usefulness and user experience of the technology were addressed. Participants were asked about their experience of using VR as well as their opinions of potential uses of the technology. It was predicted that there would be a difference in the factors deemed important for VR by those who are current users of the technology compared to those who do not use it regularly.

What are the implications for VR manufacturers? Questions pertaining to the technical characteristics that influence the quality of the experience of using VR were asked. Suggestions for improvements that could be made to such devices were collected. This information aims to provide some insights that manufacturers can use for future iterations of such devices.

What risks are associated with VR? Health, safety, security, and privacy issues or concerns related to the use of VR and AR were investigated. Questions delving into the types of data that can be collected by AR and VR devices, related to potential concerns over user monitoring, data privacy and behaviour, and mood modification through the use of personalised content [88,89] were included. All of these factors are important considerations for the individual and societal acceptance of these types of technology. If individuals are not confident in the privacy of their own data, if non-users have concerns about covert or overt video and audio capture, or if there is a sufficient lack of trust in the way that companies select and personalise content, then the technology may be less likely to be accepted.

2. Methods

2.1. Setup and Procedure

The questionnaire was created in Qualtrics, with five blocks of categorised questions. A total of 50 possible questions were included, which are presented in Appendix A.

Participants were first presented with the study's information and consent form. Two forced-choice options for consenting appeared: if participants did not consent, the study was programmed to end with a thank-you note. Those who did consent were able to access the questionnaire.

2.2. Data Collection

Opportunity sampling was used by posting the questionnaire on the University of Essex's Department of Psychology online participant recruitment forum. Students were rewarded with 0.5 course credits for taking part. Additionally, the questionnaire was publicised on Twitter, LinkedIn, and through word of mouth in order to recruit a broader range of volunteer participants. Participants were also encouraged to spread the link to others who may have been interested in the topic.

The overall number of data sets collected was 178, with 158 arising from the university's online participant recruitment system and 20 from external sources. However, 34 were excluded from the analyses as not representing full and unique sets of responses. Of this, there were 14 who started but did not complete the questionnaire and 20 where the participant completed the survey multiple times. In these repeat cases, only the first attempt was included in the analysis.

2.3. Data Analysis

Data analysis was performed using R 4.0.3 and RStudio 2021.09.0.

Percentages and frequencies for each possible response were calculated for the responses to the closed questions, as appropriate.

Responses on the Likert scales were analysed using the Wilcoxon signed-rank test with continuity correction. This one-sample test was conducted against the middle value of 3 (labelled as `neither disagree nor agree`). The test therefore indicates cases in which the median responses differ from this neutral, central category.

Barnard's exact test was conducted on those questions, which addressed factors that might affect the enjoyment of virtual reality. This allowed the assessment of, for example, whether enjoyment of VR was affected by auditory or visual impairment or motion sickness. This test was used given the small number of predicted values in some cases and the conservative nature of the alternative, Fisher's exact test.

For each of the free-text questions, one of two qualitative analysis techniques was conducted. Prior to this, and as part of the pre-processing, filler words, punctuation, and numbers were removed. The removal of words such as 'an', 'I', and 'the' allowed for the qualitative analysis techniques to identify semantically meaningful words.

The first technique used was sentiment analysis. This uses natural language processing and text analysis techniques to identify subjective information from text [99]. The analysis can be used on a document as a whole [100], a sentence [101], or words individually [102]. The polarity of sentiment (positive or negative) behind the words or phrases is identified through this method of analysis. Here, the analysis was conducted at the word level. Sentiment analysis was implemented on the following questions using the `comparison.cloud` from the `wordcloud` package [103]:

- `8: What do you associate VR with?`
- `17: Mobile phones can record data through cameras, microphones, location services, and browser history. Some of these features can be turned on and off; however, many downloadable applications require access to these features in order to work. Do you have any opinions on the data that is collected on you from your mobile phone?`
- `24: Do you have any opinions on the data that is collected on you from a VR headset?`
- `26: What are your thoughts on VR becoming a daily commodity?`

The frequency of individual words was first calculated, and then the positive and negative associations for each word were retrieved from the package. The words were sorted into their sentiment category, and the frequency of each word directly impacted the size of that word in the wordcloud. The words needed to have a frequency of more than two to appear in the cloud. For the standard wordclouds presented, only the frequency of individual words within and between participant responses was counted and plotted using the same package. This analysis thus achieved two goals: identifying the most frequent responses and categorising these as positive or negative sentiments.

Additionally, correlated topic model analysis was used from the `topicmodels` package [104]. In this form of analysis, topic proportions were identified in the free-text answers, and correlations were identified after implementing a logistic normal distribution [105]. The algorithm then derived a variational inference [106]. The words associated with each of the topics found are then displayed in graphs, with beta weightings identifying the probability of a word occurring in a given topic (term distribution). The number of themes set for the algorithm to detect was intuitively decided upon, as was the number of terms within the theme to display. Higher beta weightings suggest a word is more likely to appear in the text. This analysis was conducted on question `28: What precautions do you think` `need to be taken when using VR?` in order to probe in detail potential concerns about the use of VR.

3. Results and Discussion

3.1. Demographics of Respondents

A total of 144 individuals successfully completed the questionnaire. Demographic information shows the gender split was 88 (61%) female, 55 male (38%), and 1 other; age ranged from 18 to 61 (mean = 23.44, standard deviation = 7.50); 69 (45%) had 20/20 vision or better. Of those who did not have 20/20 vision when uncorrected, 53 (37%) wore glasses, 22 (15%) wore contact lenses, and 15 (10%) did not know the accuracy of their vision, as they had never had an eye test. Only 10 of the 144 participants had ever had a test to determine whether they were able to perceive binocular depth, so it was not possible to relate responses to stereoscopic perception.

Generations are broadly categorised by age; generally speaking, the *Silent Generation* are those who lived through World War 2; *Baby Boomers* were those born during the surge of births after the war; *Generation X* were born when technology was quickly advancing but was not readily available; *Millennials* are the digital natives who were born as the world migrated from analogue to digital; *Generation Z* have never known a life without digital technology due to its mass availability [107]. The results here show that the most common generation identified was Generation Z (n = 61), followed by Millennial (n = 41).

3.2. Who Uses VR?

The first research question aimed to determine who from the population uses VR. Here, a Barnard's exact test was used to determine whether the proportion of participants who had tried VR differed across groups. Gender differences, as well as the effect of motion sickness and sensory impairments, were assessed, both of which might be expected to reduce engagement with VR.

The proportion of male participants (78%) who had tried VR was higher than the proportion of female participants (61%, p = 0.0228).

There were 46 participants (32%) who experienced travel-induced motion sickness, consistent with the expected incidence of between 25% and 41% [108]. In addition, 22 (15%) experienced technology-induced motion sickness. Visual impairments (not including wearing glasses or contact lenses) were experienced by 11 individuals (8%), and 7 (8%) experienced auditory impairments.

The proportion of participants trying VR was not affected by visual impairment (73% with visual impairments who had used VR, versus 67% without, p = 0.652), auditory impairment (71% versus 69%, p = 0.810), or technology-induced motion sickness (64% versus 68%, p = 0.586). However, fewer people who experience travel sickness had tried VR than those who do not (57% versus 72%, p = 0.038).

For those who had tried VR, whether the enjoyment ratings varied across these groups was also inspected. Enjoyment of VR was not affected by visual (p = 0.554) or auditory (p = 0.277) impairment, or by motion sickness induced by technology (p = 0.0647) or travel (p = 0.498). There was also no gender difference in the enjoyment of VR (p = 0.766).

The majority of the participants reported enjoying entertainment such as the theatre (n = 131, 91%), watching television (n = 141, 98%), and playing board games (n = 120, 83%). Other activities that were enjoyed by the majority were online (n = 98, 68%) and offline (n = 106, 74%) gaming. By assessing how engagement with these activities was associated with experience and enjoyment of VR, it was revealed that people who enjoy online games were more likely to have tried VR (p = 0.0376). Experience of VR did not vary with enjoyment of any of the other activities (board games, p = 0.498; offline games, p = 0.131; television, p = 0.900; theatre, p = 0.178). Enjoyment of VR was higher in those who enjoy board games (p = 0.015) and offline games (p = 0.0064), but did not vary with any of the other activities (online games, p = 0.207; television, p = 0.093; theatre, p = 0.065).

In contrast, those participants who reported not having tried VR were asked why. Shown in Figure 3 is a word cloud for the free-text responses. The word that appeared most frequently was '*opportunity*'. There is thus still not widespread accessibility of VR.

Figure 3. Word cloud for the free-text responses to the question 'For what reason(s) have you not tried VR before?'. Larger words indicate a higher frequency.

3.3. Why and How Do People Use VR?

Only a minority of participants had not tried VR before (32.63%). Of these, the most likely reason was the lack of opportunity (Figure 3), which coincides with the behavioural control predictor of the TPB. Other, less common themes were not being able to afford it and not having any interest in trying the technology. Additionally, one participant gave the reasoning that the technology "*doesn't appeal to me. Don't like the idea of not knowing what's going on around me while having a headset on*". These themes are most consistent with those of the VR-HAM, although not all themes from any of the acceptance models were presented as reasons by any one individual.

Of the 97 who had tried VR, only 4 reported using it `often`, 14 used it `sometimes`, and 79 used it `rarely`. There were no prompts in this question, so the participants were to decide for themselves what these categories of time meant, and these are shown in Figure 4a. This appears at odds with other findings from previous research [78] that 50% of participants used VR weekly. That particular study, however, used snowball sampling on LinkedIn; therefore, direct comparisons should not be made given that the sample populations were so different.

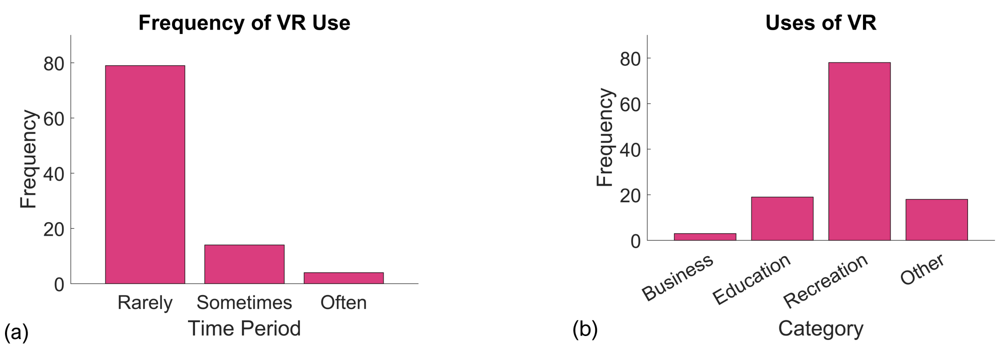

Figure 4. (**a**) Frequency of how often participants use VR. (**b**) Frequency of the reported uses of VR equipment.

A related question was asked to those who had reported trying VR before, which was when the last time they had used it (Figure 5): only one person reported to have used VR the same day as taking the questionnaire, and only one person had used it the day prior. For the other response options on when they had last used the technology: `a few days ago` $n = 6$, `a week ago` $n = 4$, `a few weeks ago` $n = 9$, `over a month ago` $n = 33$, and for `so long ago I can't remember when it was`, was the most common response ($n = 43$).

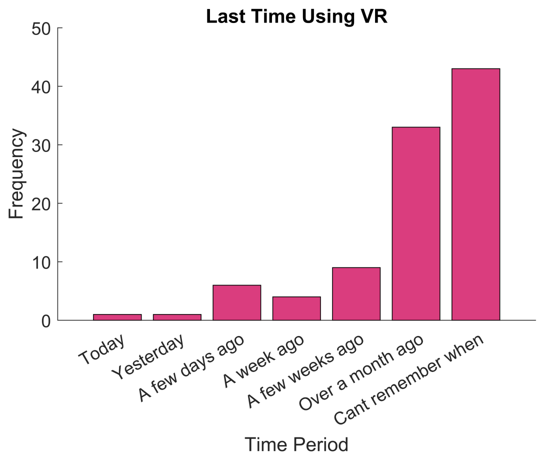

Figure 5. Frequency of the last time participants used VR.

Owning a VR device was not common: 14.58% of the sample owned a VR headset, and only three people owned more than one device. No one owned three or more.

Of those who had tried VR, 91.75% enjoyed using it. The most common of the pre-set uses for VR was for `recreational purposes` (66.10%), followed by `education` (16.10%), and the least common reported option was for `business` purposes (2.54%), which are displayed in Figure 4b. Only 15.25% of individuals responded in a free-text answer for other purposes; however, these included 'entertainment', 'gaming', and 'fun', which can be classified under the theme of `recreation`. A use for research appeared seven times, which could be included under the theme of `business`.

`Available content` was voted as the most important factor for VR, closely followed by the purchase price. Figure 6 depicts this, along with the less common responses of how `customisable` the technology is and its popularity. Popularity could be argued to be related to the social norms predictor in the TRA and TAM. Both of these models found it to significantly predict usage, in contrast with the low importance attached to it in the responses found here.

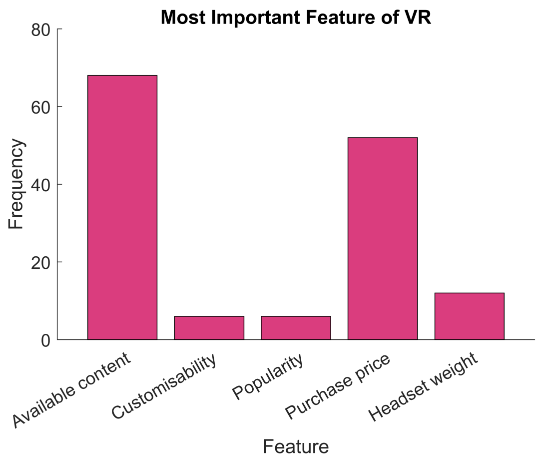

Figure 6. Frequency of the option chosen to be the most important feature for VR.

Participants were asked whether or not they agreed with eight statements that could be used to describe VR technology. Figure 7 plots the responses to these Likert questions: there were few extreme responses (`strongly disagree` or `strongly agree`) for these questions. The results of the Wilcoxon signed-rank tests are shown in Table 1. These results show that VR devices were perceived to be easy and enjoyable to use, necessary, but also bulky.

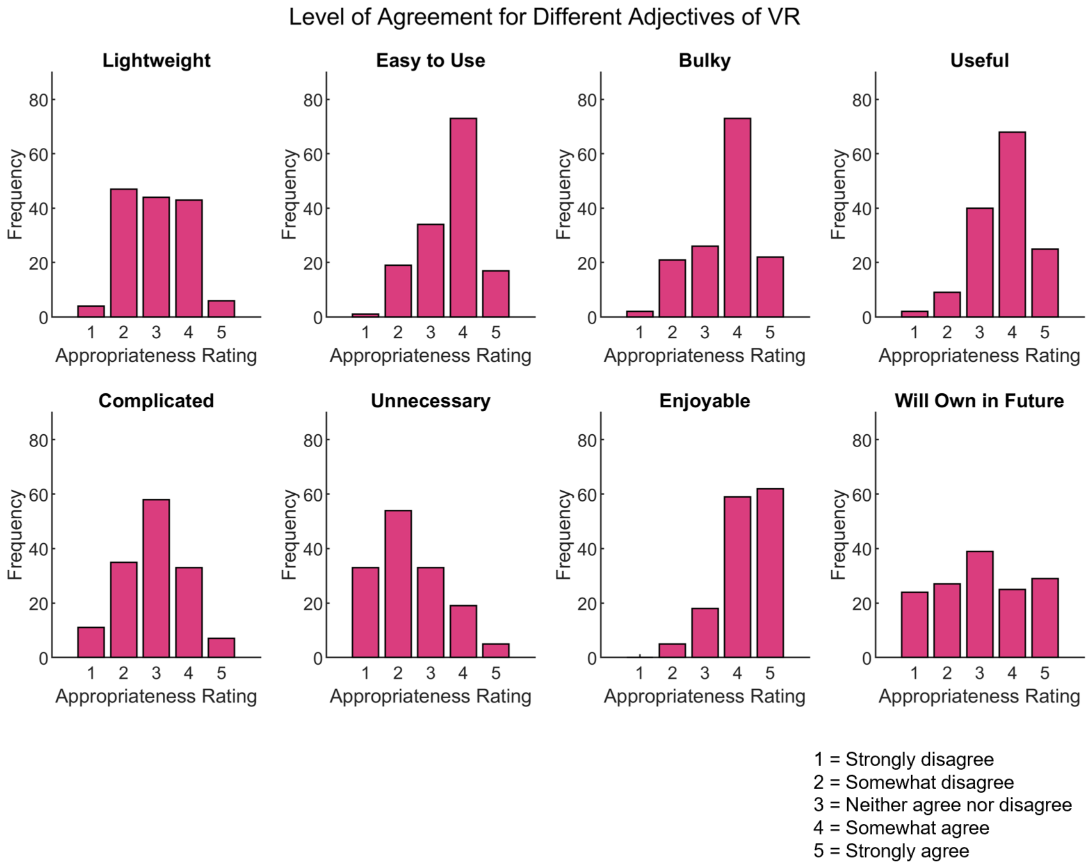

Figure 7. Frequency of the ranked appropriateness of different descriptions of VR devices.

Table 1. Output from the one-sample Wilcoxon signed-rank test on the 5-point Likert style question 'what are your thoughts on the VR headsets themselves?'.

Prompt	V	p	Direction
Lightweight	2529.5	0.988	Neutral
Easy to use	5120	<0.001	Positive
Bulky	5810.5	<0.001	Positive
Useful	4927	<0.001	Positive
Complicated to set up	1681	0.385	Neutral
Unnecessary	1165.5	<0.001	Negative
Enjoyable to use	7838.5	<0.001	Positive
I will own one in the next few years	2953.5	0.574	Neutral

Perceived ease of use has been found to have a direct effect on intention to use [109]; however, other studies found this effect to actually be mediated by perceived usefulness [110]. A more recent study found that perceived usefulness was the most important factor [111]. Here, however, both `ease of use` and `usefulness` were not considered to be among the most important characteristics of VR (Figure 7).

When asked to rank the importance of four different sensory features of VR devices (Figure 8), having `accurate head-tracking` was rated the most important, closely followed by `visual graphics`. The features that participants ranked the least important for VR devices were `high-quality sound` and `haptic feedback` from controllers.

Only 11 out of the 97 who had tried VR before had adjusted their VR device to match the lens separation to their own interpupillary distance, yet 24 reported as having had this distance measured previously. It is important that this is recognised, despite the opportunity to set the image positions to match the observer's distance between their eyes (IPD) in many headsets, due to the problems in the realism and the comfort of the VR experience that can accompany an incorrect IPD [9,112]. Moreover, of those who reported to needing to wear glasses, only 14.70% wore them while using VR (23.52% reported sometimes wearing them).

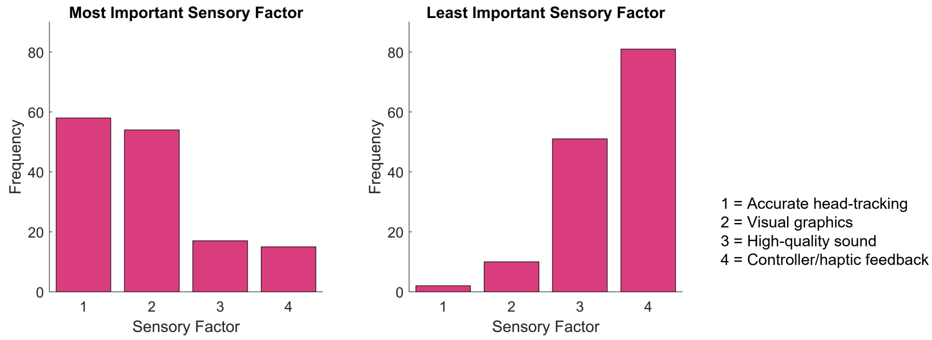

Figure 8. Frequency of the sensory factor rated most and least important for a VR device.

One free-test question asked in what ways participants thought VR could benefit them personally. Occurring 19 times was the word '*entertain*'; related words such as '*game*' (n = 10), '*gaming*' (n = 12), '*fun*' (n = 17) indicate that the theme of recreation was the most common in the responses to this question. This coincides with the forced choice options from the question shown in Figure 4b, where recreation was the most chosen answer to what VR was being utilised for by current users.

The word '*stress*' appeared five times in the responses to what VR was being used for, in contexts such as "*take my mind off of daily stressors in real world*". Having an immersive environment that causes one to forget about the physical world is a useful tool, not only for reducing stress but also for medical interventions: "*help with fears and PTSD, maybe even just from escaping this world*". As the survey was completed during the COVID-19 pandemic, it was perhaps particularly important that this form of distraction was desired by many individuals.

In this context, experiencing places or events was a common answer; one individual elaborated: "*because of the pandemic I could not come for a campus tour but having that campus tour experience on VR could be the next best thing*". This could indeed be used as a great tool in allowing individuals to attend a university that may be hard to reach for an open day, or giving potential customers a taste of a service a business has to offer, to overcome travel or accessibility limits, or even when these are unrestricted.

Other themes, less common but appearing numerous times, include using the technology for exercise, training, and research. There are currently software programs being used in these domains, and it is positive that the public acknowledges these as having beneficial uses. On the other hand, using VR as a release from boredom appeared three times.

Participants were asked to report their thoughts on the notion that VR may become a daily commodity. Figure 9 displays a sentiment analysis conducted on the free-text responses to this question. Opposing words appear on both sides of the cloud, for example '*useful*' and '*useless*', indicating a variety of opinions. The size of the font depicts the number of times the word appeared in the answers; here, the frequency of '*useful*' was 11, and '*useless*' was two. As can be seen in this cloud, '*useful*' had a higher frequency than '*fun*', which aligns with the TAM but not the VR-HAM. In addition, 57.64% of participants could see VR becoming a daily commodity in the next few years.

Shown in Figure 10 are the responses when asked to rate the appropriateness of `facial recognition`, `eye-tracking`, and `content personalisation` in VR and on mobile devices. Similar levels of appropriateness were reported for both technologies; the results of Wilcoxon signed-rank tests on these data are presented in Table 2. This shows that participants felt that facial recognition and eye-tracking were appropriate on both mobile devices and VR. They were overall neutral on the subject of content personalisation on both platforms. Interestingly, content personalisation had mixed reports, with enough variance for the test to report no significant direction in responses.

Table 2. Output from the one-sample Wilcoxon signed-rank test on the 5-point Likert style question 'what are your thoughts on…'.

Prompt	V	*p*	Direction
Facial recognition on mobile devices	6057	<0.001	Positive
Facial recognition on virtual reality devices	4188.5	<0.001	Positive
Eye-tracking on mobile devices	8272.5	<0.001	Positive
Eye-tracking on virtual reality devices	7308.5	<0.001	Positive
Content personalisation on mobile devices	3615.5	0.899	Neutral
Content personalisation on virtual reality devices	4348.5	0.003	Neutral

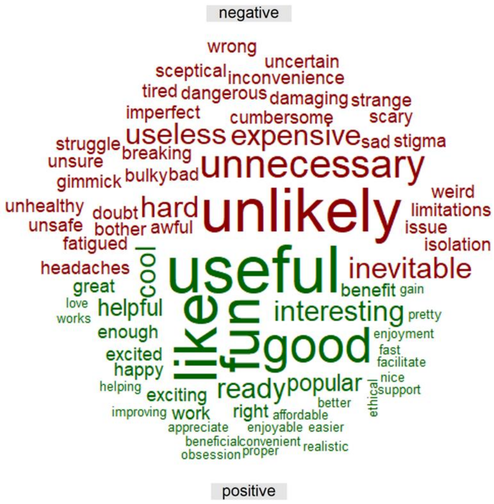

Figure 9. Sentiment analysis conducted on the free-text responses to the question 'what are your thoughts on VR becoming a daily commodity?'. Larger words indicate a higher frequency, sorted into positive and negative categories.

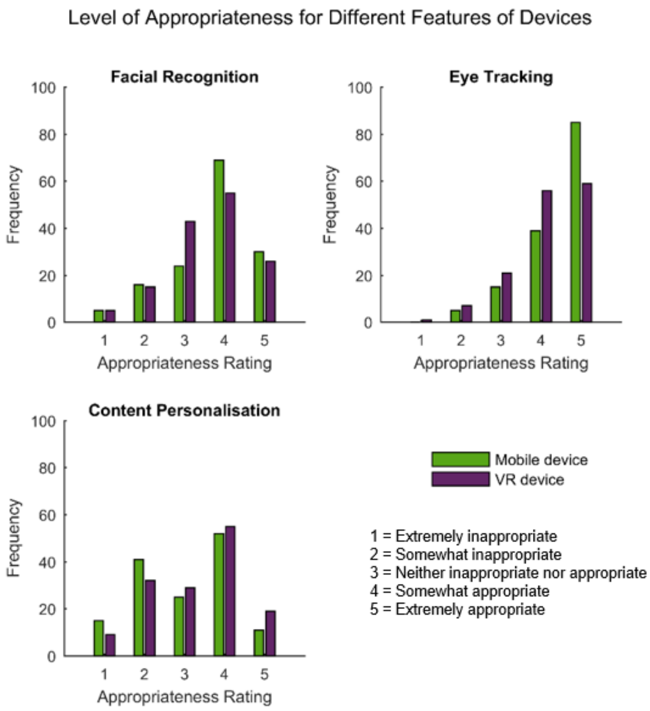

Figure 10. Ranked level for how appropriate each type of data collection is perceived to be, for both mobile and VR devices.

3.4. What Risks Are Associated with VR?

Participants were asked to explain any precautions they believed needed to be taken when using VR. The free-text responses were analysed using topical analysis. This type of analysis was used to detect themes, and the four retrieved topics generally make sense in relation to the question that was asked. The terms and themes are displayed in Figure 11. The themes that the algorithm detected were interpreted as being: (1) physiological risks; (2) safety and privacy; (3) the disconnect between virtual and physical space; and (4) safety in the physical environment.

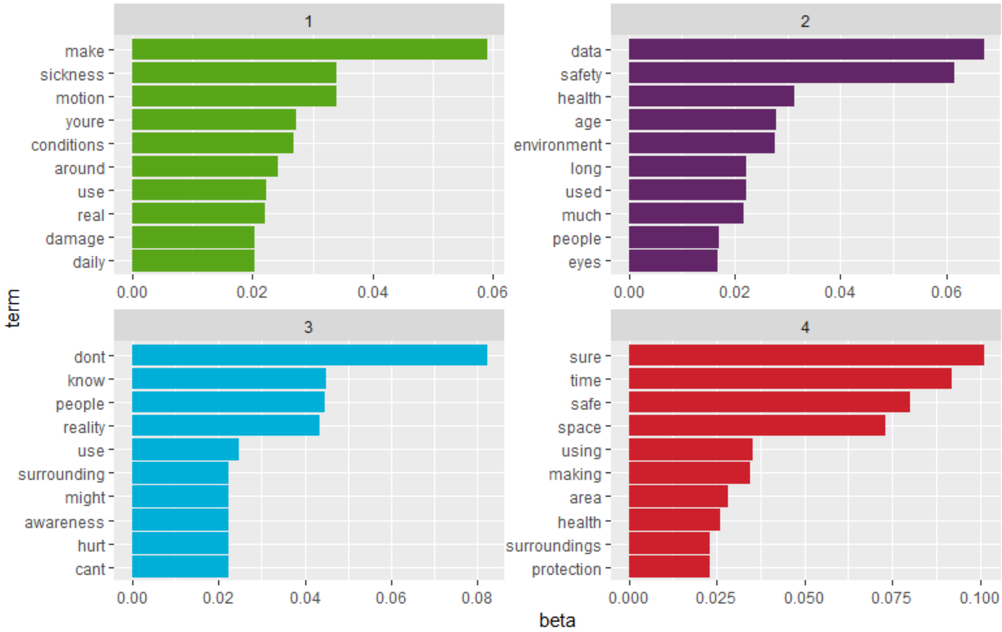

Figure 11. Topical analysis showing four themes detected by the CTM algorithm and the beta weighting of the 10 most frequent terms in response to the question 'what precautions do you think need to be taken when using VR?'. Topic *1* was interpreted to surround physiological risks; *2* privacy; *3* disconnect of virtual aspects from physical space; *4* secure environment.

<u>Theme 1</u> is focussed on the negative side effects of usage, such as the potential for motion sickness and strain on eyesight ('*damage*', '*sickness*', '*daily*'). These are all concerns that are associated with the technology [113–116]. Relating back to many of the acceptance models, an individual's experience of any such effects will have an impact on the chances of them becoming frequent users of the technology (Figures 4a and 5).

Participants were asked about any concerns they thought should be taken into consideration both when using VR technology (from the perspective of a customer) and when creating the technology (from the perspective of a manufacturer). Safety precautions ('*health*', '*safe*', '*safety*', '*sickness*') appeared 41 times in the free-text response to precautions for users (Figure 12a). In contrast, the most common concern envisaged from the perspective of the manufacturer was comfort ('*weight*', '*heavy*', '*light*', '*comfortable*', '*comfort*' frequency = 36), as can be seen in Figure 12b.

<u>Theme 2</u> consists of terms related to online safety and security. The top three terms ('*data*', '*safety*', and '*health*') suggest a cohesive theme of user privacy and safety, which was a recurring theme within free-text responses to other questions, as can be seen in Figures 12 and 13.

The word '*data*' appears when participants were responding from the perspective of both users and manufacturers (Figure 12), showing the concern individuals have over the data that is collected by VR devices. VR equipment collects new types of data compared to playing a non-VR game or watching non-VR content, such as the potential for detailed tracking of the user's behaviour and movement in their own home, which may be a cause for concern among the public. Related to this, direct questions were asked about opinions on the types of data that are collected from users of both VR and mobile devices. Figure 13 presents sentiment clouds for the free-text responses to these two questions: There were fewer common words appearing in the question about VR devices, which is why there are fewer words in the cloud.

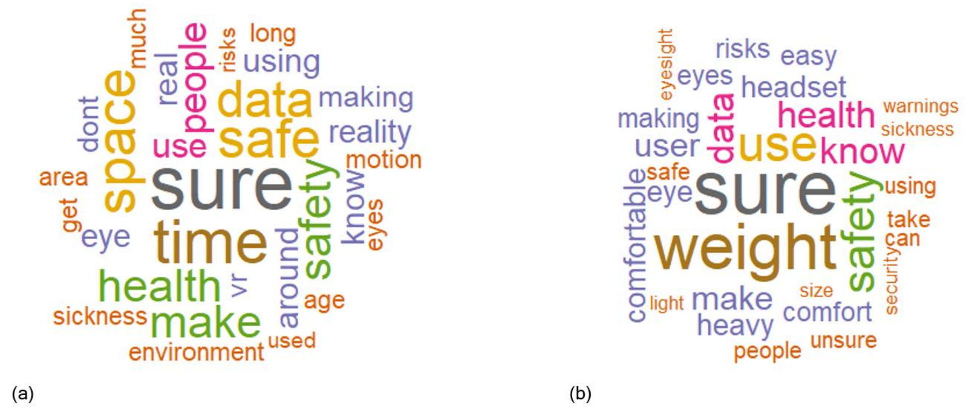

Figure 12. Word cloud for the free-text responses to the question 'what precautions do you think need to be taken when...'; (**a**) prompt 'using VR?'; (**b**) prompt: 'creating a new VR headset?'. Larger words indicate a higher frequency.

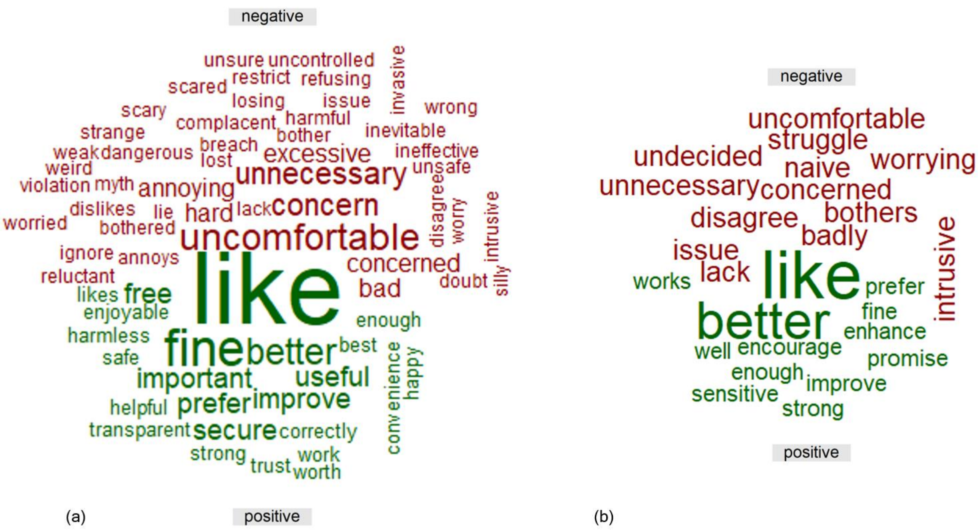

Figure 13. Sentiment analysis clouds for the free-text responses to the question 'Do you have any opinions on the data that is collected on you, from...?'; (**a**) prompt: your mobile phone; (**b**) prompt: a VR headset. Larger words indicate a higher frequency, sorted into positive and negative categories.

Participants had many overlapping views on how data is collected from mobiles, and within the transcripts, it is apparent that the public is aware that lots of information about them is continuously being collected: "*It makes me uncomfortable to even think about it*". However, they are also aware that there is little they can do to prevent it ("*I have a concern for my data security, data ownership, and usage. Typically, I'll try and restrict the data that is accessed, although I am aware that is somewhat a losing battle*") and they do not understand what their data is being used for ("*I get a strong feeling that often my data is used without me knowing what it is used for. I don't trust it but also don't see much way around it*"). Some individuals were actively taking a stand against this: "*I would delete a game if it didn't work because it wants access to my contacts*", although past experiences have enlightened the public and cast a negative light on the data industry: "*Data privacy is a myth. Cambridge Analytica proved that. Our data can be weaponised against us to persuade us into voting for candidates, buying* *things online, etc*". Contrary to this, indifference to the issue did appear: "*I don't care, I have nothing to hide*"; however, this was an uncommon theme. More common was the idea of reimbursement for the data being taken: "*I've given up most, if not all, of my data for free! I should be getting paid for it*".

The responses to the question on data collection through VR devices were similar, sometimes not being on board with the collection of data in the first place ("*I would really rather that my data isn't collected; it's an invasion of privacy*"), while also wanting to understand how the information will be handled ("*I need to know what it is, what it is used for, and whether it will be anonymous*"). As the technology is still relatively new and developments are still underway, individuals are sympathetic to this: "*If it is for optimizing the technology, then it is ok; if it is for the sake of profiting, then I am strongly against*" although there may be a disconnect between what the manufacturers would consider a valid use ("*I don't mind them using my data only if it's for a valid reason*"). Nonetheless, individuals feel some sort of compensation should be offered for the personal data that is accumulated ("*I'd like to know what data, how its used, and get paid for if I give it up*").

Theme 3 contains terms that, while somewhat disparate, relate to the topic of immersion and presence and the concern that awareness of one's physical surroundings is impaired by having a headset on.

Theme 4 focusses on safety within the physical environment, including terms such as '*area*', '*health*', '*surroundings*', and '*protection*'. Having a safe environment to use VR is a sensible idea and is often recommended within VR software during gameplay via in-built guardian systems. Many accidents that have been publicised online [117] could have easily been avoided by ensuring there is enough open space around the individual to engage in the virtual environment without hitting or bumping into something or someone. This focus on potential hazards in the physical environment complements Theme 1, which addresses the potential negative effects of the technology itself.

3.5. Implications for Manufacturers

A concerning issue of privacy was unsurprisingly apparent here. Participants feared for the way their personal data is used (potentially against them) and without their informed consent. The development of eye-tracking in VR was accepted as appropriate. Content personalisation had mixed reviews for its place in VR; this could include the presentation of advertisements in the headsets. VR manufacturers should take special care when it comes to the privacy and protection of their users' data.

One free-text question asked participants to explain what improvements they thought should be made to VR devices. Descriptors surrounding the hardware ('*weight*' $n = 22$, '*size*' $n = 5$, '*wires*' $n = 4$) appeared the most times, with all who mentioned this requesting the device to be made smaller, lighter, and without cables. The weight and bulkiness of devices were noted in Figure 10 and appear again here without prompts. Components of the hardware, such as weight and form factor, arose in multiple other responses: the term '*comfortable*' in Figure 12b, '*uncomfortable*' in Figure 13b; '*bulky*' was agreed upon by the participants as an appropriate term to describe VR technology in Figure 7.

Likely a result of the hardware composition, pricing was also a notable theme within the responses of this questionnaire. In Figure 6, the price was found to be the second most important feature rated for the technology, and the weight was ranked third. Manufacturers should take this information on board when aiming future devices at populations that may have restricted disposable income.

The topic of health and safety appeared in the responses to numerous different questions (Figures 9, 11 and 12). Individuals have shown concern over the side effects that can occur when using VR technology, such as motion sickness and eye fatigue. Related factors within this topic include tripping hazards, the amount of space required to use the technology, and reduced awareness of one's surroundings.

Having a reduction in the cable length or using wireless devices would be one way manufacturers can combat this safety issue, with the removal of cables causing a reduction in tripping hazards. One participant noted: "*incorporating some form of physical apparatus that can truly immerse yourself in a new virtual world without major risk of injury*". The addition of physical apparatus to reinforce the virtual guardian system, which is present in many devices, is suggested here to enhance the immersive experience; however, it might work in the opposite way as a grounding feature for the physical world.

With the risk of eye strain and other physiological issues being a prominent theme, the suggestion of having break announcements was suggested as an improvement. When the user has been involved in a virtual environment for an extended period of time, a reminder to take a break would be a helpful way to avoid such issues. This would aid in reducing some of the other health and safety-related side effects of the technology that have arisen in other questions.

While VR technology has been around for decades, it is currently more available and usable than it has ever been. It has been noted [118] that during the COVID-19 pandemic, VR played a vital role in medical marketing, disease awareness, medical training, and learning. This is encouraging for the acceptance of VR outside of pandemic times if more similar applications can be developed. Throughout the pandemic, the importance of physical activity was also appreciated by many; over half of the population reported wanting to do more physical activity once the pandemic restrictions eased [119]. Applications of VR can be further developed in the domain of sports and exercise; however, tripping hazards and guardian systems are critical for these applications. VR software is currently being used, for example, in training for football [120], volleyball [121], and perception-action tasks for predicting opponents' behaviour with rugby and handball [122]. Considering that the bulkiness of the headsets and price are issues for consumers of VR devices, these factors need to be modified by the manufacturers in order to increase the likelihood that medical professionals or sports teams adopt them in their training practices.

Haptic feedback was not considered an important sensory feature of VR by the participants of this study. This could mean that the majority of efforts from manufacturers might therefore be placed on enhancing the head-tracking and developing the available content. This, along with reducing the weight and bulkiness of the headset itself, would go a long way toward pleasing potential and existing consumers. Other hardware obstacles include focal distance and accommodation conflicts. One individual pointed out that efforts need to "*compensate for eye focus difficulties, short or long-sightedness*". It is important, however, to appreciate that the majority of people will be unaware of the benefits of haptic information in VR and may thus not appreciate the contributions it can make to the VR experience.

Research has suggested that direct product experience is the best way for consumers to evaluate a product [123–125]. Due to this, there were branches in the questionnaire that appeared only to those who already had familiarity with VR. In contrast, some of the analysis was conducted to collate the opinions of only users of the technology. In one question here, participants were asked about their opinions on some VR manufacturers and what these opinions were based on. This was a closed question, with options to select either having `knowledge on the bands generally` (n = 63), the individual's `own experience` (n = 31), or `other` (n = 45). Many of those who selected `other` elaborated in a free-text option by stating that their opinion of the brand's ranking was based on a combination of both prior experience and general knowledge. A number of individuals declared that they had only heard of one or two of the brands; others reported not having any knowledge of any of them. These results emphasise the importance of marketing and advertising.

Corporate associations and product reputations are important factors in marketing [126]. All participants were asked what they associated VR with. Figure 14 shows how the cost of the equipment, the fact that what is displayed in the technology is not real, and the idea of it being a '*threat*' are the most common associations. These link to many of the acceptance models, as well as the responses to other much more related questions: Figure 12b and Table 1.

Figure 14. Sentiment analysis conducted on the free-text responses to the question 'what do you associate VR with?'. Larger words indicate a higher frequency, sorted into positive and negative categories.

4. Comparison with Manufacturer Responses

A related survey was conducted with participants from industries involved in VR/AR/MR technology [127], with questions that delved into the factors that were deemed important for the adoption of these technologies. A total of 191 professionals from established technology companies (47%), start-ups (19%), consultants (16%), investors (12%), and policymakers (5%) took part in the survey in 2020. The following section compares the responses found in the current study to those reported in that survey.

One question in the survey asked what the biggest obstacle to mass adoption of AR and VR was. The most common answer for VR was content offerings, followed by user experience. For AR, user experience was judged the most important factor, followed by content.

User experience includes features such as bulkiness and technical issues; in the study of potential users, participants agreed that VR headsets were somewhat bulky and had an ambivalence about whether or not they would own a headset in the future. This, in combination with Figure 6, is in agreement with the industry survey. However, purchase price was ranked second most important here, whereas only 11% of manufacturers ranked the cost to consumers as important. In another question, manufacturers reported that a reduction in the size of the devices would be the top improvement to VR software in the following two years, which will address some of the concerns on this aspect that were expressed in the current survey.

In response to the question asking manufacturers to identify what their biggest concern to their own organisation was, 61% stated consumer privacy/data security in 2019, which reduced to 49% in 2020. It is reassuring that the companies are aware of this being an issue, as this also appeared in the free-text responses in the current study when participants were asked what precautions the manufacturers need to take into consideration. Data protection also emerged, both in the responses for what manufacturers need to take into consideration and also for users of the devices. Just over half of manufacturers (54%) stated that they had updated their privacy policies and disclosures regarding consumer data, however less than half (48%) stated that they were limiting the amount of personal information from consumers that are collected/shared/used. The manufacturers are not currently taking the steps desired by consumers to overcome these privacy issues but are relying on terms and conditions that are unlikely to be read by consumers [128].

A total of 47% of manufacturers stated that they would earn from having product placement within the immersive experience of VR devices. This might be beneficial for those users who deemed content personalisation somewhat appropriate inside VR if they visualised getting personalised recommendations for other games they might enjoy but not advertisements for non-related products or services being offered in the physical world.

Suggestions for improvements to VR technology were invited in the current study, and alterations to the hardware appeared to be most agreed upon. The manufacturers were asked a similar question to state what improvements would make the greatest impact for consumers; here, hardware improvements were not ranked in the top five. Solutions for application experiences, bugs, compatibility, connectivity, and cyber-security were all detailed as being more important for the manufacturers when taking the perspective of the consumers.

Less than half of the participants here thought that VR would become a daily commodity in the next few years; more manufacturers reported immersive technologies becoming mainstream in the two to five years after the survey than any other time period.

It was reported that 76% of manufacturers anticipated that the AR market would surpass the VR market, mainly due to the cost and accessibility of AR compared to VR. Most expected this to occur within three to five years after the survey was conducted. In the current study, only 36.73% of participants had tried AR, compared to 67.37% who had tried VR. Increased experience with AR is still, therefore, an unfulfilled requirement for its success in comparison with VR. With developments in technology, marketing, and accessibility, this may change in the future; however, based on acceptance models, it is safe to assume that they have little intent to try the technology or even curiosity about it for the time being.

5. Limitations of This Study

In Section 3.1, the participants who took part in this study are outlined. Of the 144 unique and complete datasets, the mean age of respondents was 23, and the most common generation was reported as being Generation Z. This bias in participant ages may therefore be a limitation of the findings, as they may not be generalisable beyond this majority. Similar research in the future would benefit from gathering more representative participant samples, especially if the goal is to determine why certain groups have chosen not to indulge in such technology.

Older generations have been found to experience more technology-related anxiety than the younger ones [129–131], which may act as a deterrent from using VR. This may have also influenced the participants recruited to take part in this questionnaire, as the majority of recruitment took place online.

It should be noted that the word '*like*' appears frequently in the responses to both questions; it is included although its use in the free-text responses is used both to express emotion ("*I do not like that they can use and see our data*") as well as a filler term ("*Seems like a lie to try and get data*"). In addition, '*better*' is frequent, although only used to express interest ("*sometimes needed for better gameplay*"; "*the lesser the better*"). During the qualitative analysis, it is therefore important to note the context in which certain words are used. Automatic algorithms that analyse use may not take this into consideration; however, based on the output word clouds, it appears the packages used here likely do.

The advancement of the technology outlined in this study is ongoing; new and improved iterations of VR devices are released frequently. A limitation of this work is that the user experiences and perceptions obtained may not be applicable to future iterations of the hardware. It is therefore important to keep up to date with the perceptions surrounding the latest releases, which is why it is necessary for similar research to be conducted routinely.

6. Summary

The current study assessed the degree of experience and enjoyment of VR, the factors believed to be important for the uptake and development of the technology, and concerns that people have about its use. Here, 67% of individuals reported to have used VR, but the majority of these individuals did not use the technology often. From those who had used the technology before, 92% enjoyed using it; the most common use for VR was recreation. The percentage of people who had used VR was slightly higher for men than women and lower for those who experienced motion sickness.

The most important attributes of VR were rated as being the available content, price, ease of use, enjoyment, and bulkiness of the headset. When asked how VR might be improved, people indicated the desire for headsets to be smaller, lighter, and wireless.

Participants were also asked about their concerns about the technology. The most important of these were the potential for discomfort, sickness, and eye strain; the disconnect from the real environment when in VR; the risks from the lack of awareness of the real-world surroundings that results from this disconnect; and the privacy and use of data collected while using devices.

The results of this research were somewhat consistent with the findings of similar research conducted on individuals who work in this specific technology industry. The differences in opinions of consumers/novices (such as those partaking in the present research here) compared to industry professionals provide solid grounds for future development of the technology, and it would be beneficial for the industry manufacturers to take these perspectives into consideration for future product iterations.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of the University of Essex on 1 December 2020: ETH2021-0267.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The original data presented in the study are openly available in the University of Essex's Research Data Repository at https://researchdata.essex.ac.uk/142/.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Abbreviations

The following abbreviations are used in this manuscript:

VR	Virtual Reality
TRA	Theory of Reasoned Action
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
VR-HAM	Virtual Reality Hardware Acceptance Model
AR	Augmented Reality

Appendix A. Questionnaire Questions

1. `Consent` - options to `Accept` or `Decline`; if `Decline` selected skip to end of questionnaire

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2. `What is your age (in years)?` - free-text, numerical
3. `Which generation do you associate yourself with?` - options `Generation Z, Millennial, Generation X, Baby boomer, Silent generation, I don't know`
4. `What is your gender?` options `Male, Female, Other`
5. `Do you have 20/20 vision, or better?` - options `Yes, No, Don't know because I've never had an eye test`
   (a) display if `Q5 = No` - `Do you wear glasses?` - options `Yes, No`
   (b) display if `Q5 = No` - `Do you wear contact lenses?` - options `Yes, No`

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6. `Do you own a VR device?` - options `Yes, No`
   (a) display if `Q8 = Yes` - `Which VR headset do you own?` - free-text

7. Have you tried VR before? - options Yes, No
    (a) display if Q7 = No - For what reason(s) have you not tried VR before? - free-text
    (b) display if Q7 = Yes - How often do you use VR? - options Rarely, Sometimes, Often
    (c) display if Q7 = Yes - Do you enjoy using VR? - options Yes, No
    (d) display if Q7 = Yes - What purposes do you use VR for? (select all that apply) - options Educational, Recreational, Business, Other: (free-text)
    (e) display if Q7 = Yes - When was the last time you used VR? - options Today, Yesterday, A few days ago, A week ago, A few weeks ago, Over a month ago, So long go I can't remember when it was
    (f) display if Q7 = Yes - Have you ever had the distance between your eyes/pupils measured? - options Yes, No
        i. display if Q7f = Yes - Do you adjust the setting on the VR device to match the distance measured between your eyes/ pupils? - options Yes, No
    (g) display if Q7 = Yes and Q5a = Yes - Do you wear your glasses when using VR? - options Yes, No
8. What do you associate VR with? - free-text
9. What are your thoughts on the VR headsets themselves? - items Lightweight, Easy to use, Bulky, Useful, Complicated to set up, Unnecessary, Enjoyable to use, I will own one in the next few years; options Strongly agree, Somewhat agree, Neither agree nor disagree, Somewhat disagree, Strongly disagree
10. Rank these sensory factors for what is most important (1) to least important (4) in VR for you: - options Accurate head-tracking, Visual graphics, High-quality sound, Controller/haptic feedback
11. What is the most important to you when it comes to a VR headset? - options Price, Weight, Available content, Popularity, Customisability

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12. Have you ever had a text to check if you were able to perceive 3D stimuli? - options Yes, No
13. Do you experience travel-induced motion sickness? - options Yes, No
14. Do you experience technology-induced motion sickness? - options Yes, No
15. Do you experience any visual impairment (not including wearing glasses/ contact lenses)? - options Yes, No
16. Do you experience any auditory impairment? - options Yes, No

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17. Mobile phones can record data through cameras, microphones, location services, and browser history. Some of these features can be turned on and off, however many downloadable applications require access to these features in order to work. Do you have any opinions on the data that is collected on you, from your mobile phone? - free-text
18. Facial recognition is the technology used in mobile phones which allows for the phone to recognise when the owner is using the phone. This feature can be used for security purposes (such as automatically unlocking the phone when the owner is looking at the screen), but can also be used for entertainment purposes (creating personalised avatars with filters). What are your thoughts on facial recognition on mobile devices? - options Extremely appropriate, Somewhat appropriate, Neither appropriate nor inappropriate, Somewhat inappropriate, Extremely inappropriate

19. What are your thoughts on facial recognition on VR devices? - options Extremely appropriate, Somewhat appropriate, Neither appropriate nor inappropriate, Somewhat inappropriate, Extremely inappropriate
20. Eye-tracking is the technology used in research experiments to know where the individual is looking within a scene that is presented to them. This can be used to see where a person's focus is, and for how long specific areas hold their attention. What are your thoughts on eye-tracking during research experiments? - options Extremely appropriate, Somewhat appropriate, Neither appropriate nor inappropriate, Somewhat inappropriate, Extremely inappropriate
21. What are your thoughts on eye-tracking within VR devices? - options Extremely appropriate, Somewhat appropriate, Neither appropriate nor inappropriate, Somewhat inappropriate, Extremely inappropriate
22. Content personalisation is a marketing strategy that presents content which is deemed relevant for a viewer, based on algorithms using previous interests and search history. What are your thoughts on content personalisation within social media advertisements? - options Extremely appropriate, Somewhat appropriate, Neither appropriate nor inappropriate, Somewhat inappropriate, Extremely inappropriate
23. What are your thoughts on content personalisation within VR content? - options Extremely appropriate, Somewhat appropriate, Neither appropriate nor inappropriate, Somewhat inappropriate, Extremely inappropriate
24. Do you have any opinions on the data that is collected on you, from a VR headset? - free-text
25. Can you see VR becoming a daily commodity in the next few years? - options Yes, No
26. What are your thoughts on VR becoming a daily commodity? - free-text
27. What ways do you think VR could benefit you specifically? - free-text
28. What precautions do you think need to be taken when using VR? - free-text
29. What precautions do you think need to be taken when creating a new VR headset? - free-text
30. What improvements do you think need to be made to the current VR headsets? - free-text
31. Rank the brands for who has created the best VR headset: - options Sony, HTC, Oculus, Samsung, Valve
32. What is your answer to the previous question based on? - options Own experience, Knowledge on them Generally, Other: free-text

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33. Have you ever used augmented reality? - options Yes, No
34. Have you ever used mixed reality? - options Yes, No
35. Do you enjoy theatre productions? - options Yes, No
36. Do you enjoy watching movies or TV programmes? - options Yes, No
37. Do you enjoy online gaming? - options Yes, No
38. Do you enjoy offline gaming? - options Yes, No
39. Do you enjoy board games? - options Yes, No
40. Which gaming consoles do play on? - options PC, Microsoft Xbox, Sony PlayStation, Mobile phone/tablet, Nintendo, None, Other: free-text

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