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What About the Real Use of Virtual, Extended and Augmented Reality? A Survey of a French Representative Sample

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ABSTRACT

Literature provides few if no data on the current use and exposure of individuals to virtual reality (VR) and/or augmented reality (AR) technologies in the wild. Most of the publications concern prototypes and systems tested in laboratories, whereas actual uses in private and professional situations are poorly documented. Obtaining a clear picture of the current use and exposure to VR/A/M technologies is thus difficult, beyond high-profile applications (e.g. Pokemon GO) and devices (e.g. Oculus rift). To address this gap, a survey was conducted in the context of a working group at the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) among a sample of 776 French people aged 18 and over who have already experienced virtual or augmented reality (from a representative national sample of 2970 French people aged 18 and over) and 122 children aged 6 to 17 who have already experienced virtual or augmented reality. The online questionnaire was designed to identify the people concerned and the situations of exposure to these technologies, the type of systems and devices used, as well as to examine the possible occurrence of cyber-sickness symptoms felt after or during exposure. Beyond the lack of previous studies, a specific difficulty and limit to interpreting previous surveys lies in the emerging nature of the technologies under consideration, i.e. the fact that they are evolving technologies, still little known and/or poorly understood (especially for the general population) and responding to uses and needs that are still incompletely identified. Thus, the study's instructions relied on a precise definition of VR/AR combined with typical illustrations of the different types of devices and uses presented in the questionnaire. The results show that 26% of French people aged 18 and over have already experienced virtual or augmented reality, whereas 33% of French people with children between the ages of 6 and 17 report that their children have already experienced VR/AR. Characteristics of the users population, situations and duration of use, as well as devices mostly used are clarified. In terms of health consequences, between one-third and one-half of users report having experienced symptoms during or following exposure to VR or AR, depending on how the measurement is conducted. The most common self-reported symptoms are dizziness and headache. Symptoms mainly appear during or immediately after exposure and disappear very quickly afterwards, with the exception of headaches and visual fatigue, which seem to persist more over time. The types of use and technologies used seem to be determining factors in the occurrence of symptoms. The conclusion set perspectives to recommendations.

Keywords: Virtual reality, Augmented reality, Survey, Health and safety risk

INTRODUCTION

As part of a scientific expertise on the health impact of Virtual and Augmented reality (Burkhardt, Attia, Behar-Cohen et al. 2021; ANSES, 2021) motivated by their increasingly uses in a wide variety of fields including healthcare, training, real estate, safety and leisure-, the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) piloted a survey to characterize as far as possible the exposure of the population (workers and the general population) to these new digital technologies. The motivation was that the literature provides few if no data on the current use and exposure of individuals to virtual reality (VR) and/or augmented reality (AR) technologies in the wild. Indeed, most of the publications concern prototypes and systems tested in laboratories, whereas actual uses in private and professional situations are still poorly documented. Beyond few high-profile applications (e.g. Pokemon GO) and devices (e.g. Oculus rift), there is no clear picture of the current use and exposure to VR/A/M technologies, making difficult a public health risk assessment approach to assess the risk in terms of deleterious effects, i.e. damage to the mental or physical integrity of the person that could result of the uses and exposure. The paper reports on the survey main results.

A SURVEY OF FRENCH PEOPLE'S EXPOSURE TO AND USE OF VIRTUAL, AUGMENTED AND EXTENDED REALITIES

The aim of the survey was to identify the population group concerned and the situations of exposure to VR/AR technologies, the type of systems and devices used, as well as to examine the possible occurrence of cyber-sickness symptoms felt after or during exposure.

METHOD

Population

A sample of 776 French people aged 18 and over who have already experienced virtual or augmented reality (from a representative national sample of 2970 French people aged 18 and over) and 122 children aged 6 to 17 who have already experienced virtual or augmented reality.

Material

The questionnaire was developed by the panel of experts belonging to the working group at ANSES in collaboration with a polling expert at Opinionway. The following disciplinary fields were represented: virtual and augmented reality technologies, computer sciences, ophtalmology, physiology, ergonomics, psychology, otorhinolaryngology and social sciences. A specific difficulty and limit to interpreting previous surveys lies in the emerging nature of the technologies under consideration, i.e. the fact that VR/AR are emerging technologies, evolutive, still little known and/or poorly understood (especially for the general population) and responding to uses and needs that are still incompletely identified. Thus, the study's instructions proposed a precise definition of VR/AR combined with typical pictures of the different types of

devices and uses presented in the questionnaire. Furthermore, the questionnaire was designed to be understandable by most the people, including adults and children.

Survey

The questionnaire was administered online from August 26 to September 9, 2019 by the OpinionWay polling company on a representative national sample of 2970 French people aged 18 and over.

RESULTS

Exposure, Uses and Contexts

The results show that 26% of French people aged 18 and over have already experienced virtual or augmented reality, whereas 33% of French people with children between the ages of 6 and 17 report that their children have already experienced AR/VR. French users of AR/VR are characterized by an over-representation of the youngest age groups (18-24 years old: 17% among users versus 11% in the French population; 25–34 years old: 25% among users versus 15% in the French population; 35–49 years old: 32% among users versus 25% in the French population (Table 1).

Table 1. Experience of virtual or augmented reality among French people aged 18 years-old and over (n = 776) and children from 6 to 17 years-old (n = 122), by age; * significant positive deviation compared to the French population distribution (adults, children).

	Adults Age Groups				
	18–24 y-o	25–34 y-o	35–49 y-o	50–64 y-o	>= 65 y-o
Frequencies (%)	133 (17%)*	197 (25%)*	252 (32%)*	125 (16%)	69 (9%)
	Children Age groups				
	6–8 y-o	09–11 y-o	12–13 y-o	14–15 y-o	16–17 y-o
Frequencies (%)	11 (9 %)	36 (30%)	16 (13%)	36 (29%)	21 (19%)

The profile of adults users is also characterized by being more men (57% of users compared to 48% in the French population), from high socio-professional backgrounds (43% compared to 28%), with children (49% compared to 43%) skilled in the new technologies and living in large cities. For 3/4 of them, the exposure took place during the last 12 months, whether for private or professional uses. In about 45% of the cases, this exposure took place less than 6 months ago. Children from 6 to 17 years old have been exposed to VR and/or AR, with 9–11 and 14–15 years old as the most represented groups (Table 1), and boys were more represented (55%).

Adults reported exposures to VR (n = 665; 86% of the users and about 22% of the French population) and, to a lesser extent AR (n = 426; 55% of the users and about 14% of the French population), with an overlap of 315 respondents who declared exposure to both AR and VR (41% of the

sample or about 11% of the French population; cf. Table 2). Private uses are dominant with 85% of users (21% of French) against 51% reporting uses in the professional context. Two third of adults using VR or AR in the professional context report concomitant uses in the private context (21% of users or 6% of the French population).

Table 2. Breakdown of adults by context (private vs. professional) and technology (VR vs. AR).

	Exclusively Virtual Reality	Virtual and Augmented Realities	Exclusively Augmented Reality	Total
Private uses only	299 (57%)	147 (28%)	83 (16%)	529 (100%)
Both private and professional uses	7 (4%)	154 (94%)	3 (2%)	164 (100%)
Professional uses	44 (53%)	14 (17%)	25 (30%)	83 (100%)
Total	350 (45%)	315 (41%)	111 (14%)	776 (100%)

From 10 to 16% of adults (private context) and 25 to 28% of adults (professional context) uses VR/AR at least once a week, depending on the type of application (see Table 3). In the private context, the highest proportion of frequent use was for 3D video games alone, immersive video games alone, and outdoor AR games. In the professional context, applications for education or training was the most used, although the frequency of use was similar for all professional applications.

Regarding children (Table 4), the highest frequencies of used were found for 3D video games played alone, followed by 3D video games played in network, immersive games with glasses or headsets and outdoor AR games (see Table 4) with 29-42% of children reporting use at least once a month and 20-26% reporting use at least once a week. For all types of video games combined, the proportion of children who are frequent users is significantly higher than that observed among adults (20% vs. 15%), with two age groups exhibiting particularly high proportion of frequent users (30% of 12–13 year old and 27% of 14–15 year old play every day or once or twice a week).

The smartphone, dedicated headsets, game consoles and computers are the most frequent interfaces reported, with variations by age and context of (professional vs. Private) use (Table 5.) Both adults and children report using an average of three types of interfaces: the computer (professional context) and the smartphone (private context) are the most frequently used devices by adults (43% and 45%, respectively), while the game console is most frequently used by children (48%). Conversely, the game console is the least used interface in professional contexts (19%), while the smartphone-based headset (e.g. Google cardboard, DayDream) and immersive rooms (23% and 17% respectively) are logically the least used for private context by both adults and children.

Table 3. Uses frequencies for VR and AR application by adults (n = 776). * These are not exclusive categories: adults using applications at least once or twice a week are also counted in the other two categories; similarly, adults experimenting at least once a month. are also counted in the "at least once" category.

Type of Applications / Uses Frequencies	At Least Once*	At Least One Time per Month*	At Least Once or Twice a Week*
AR or VR games in establishment open to public.	69%	25%	14%
Video games using HMD or Glasses played alone	59%	30%	16%
Outdoor AR games (Pokemon go, Harry Potter Wizard Unite)	52%	32%	16%
3D video-games (Nintendo, 3DS…) played alone	48%	31%	16%
3D Video games (Nintendo, 3DS…) played in network	38%	27%	14%
3D immersive room/ CAVE	41%	22%	10%
Video games using HMD or Glasses played in network	38%	27%	14%
Health and rehabilitation applications	54%	43%	27%
Application for design, maintenance or repair	61%	46%	25%
Application for education and training	70%	48%	28%
Application for stock management	47%	41%	27%

In the private context (Table 6), adults spent on average around 1h30 (from 1h21 to 1h38) using VR or AR whatever the application, with the exception of immersive video games played alone with a headset or glasses, for which the average duration is lower (1h06). The professional context shows the highest average time per session for video games, followed by inventory management applications and health and rehabilitation applications (from 1 h 51 min to 1h 24), while less than one hour for the other applications. The format of the questionnaire did not allow to go into detail about the participants' activities; however, it is possible to formulate a few hypotheses, particularly with regard to the professional use of video games, which can include several different situations: use of serious games, game development, evaluation of games and activities in arcades or virtual reality rooms, development of devices and interfaces related to virtual or augmented reality, etc.

Table 4. Uses frequencies for VR and AR application by children (n = 122). * These are not exclusive categories: children using applications at least once or twice a week are also counted in the other two categories; similarly, children experimenting at least once a month are also counted in the "at least once" category.

Type of Applications	At Least Once*	At Least One Time per Month*	At Least Once or Twice a Week*
AR or VR games in establishment open to public.	79%	18%	11%
Video games using HMD or Glasses played alone	55%	35%	16%
Video games using HMD or Glasses played in network	40%	29%	20%
Outdoor AR games (Pokemon go, Harry Potter Wizard Unite)	56%	35%	17%

Table 4. Continued

Type of Applications	At Least Once*	At Least One Time per Month*	At Least Once or Twice a Week*
3D video-games (Nintendo, 3DS…) played alone	55%	42%	26%
3D Video games (Nintendo, 3DS…) played in network	37%	30%	20%
3D immersive room/ CAVE	33%	16%	10%
Health and rehabilitation applications	17%	13%	10%

Table 5. Type of devices for adults and children by context of use.

Devices/Type of Configuration	Adults-Professional Uses (N = 247)	Adults-Private Uses (N= 693)	Children (N = 122)
Smartphone	34%	45%	40%
HMD dedicated to VR	40%	37%	38%
Game console	19%	39%	48%
Computer	43%	34%	25%
Screen	38%	32%	22%
Headset or connected glasses for AR	28%	31%	38%
Tablet	33%	28%	25%
Smartphone-based Headset	31%	25%	28%
CAVE	26%	23%	17%
Other	4%	3%	1%

The children spent more than 1h30 (from 1h35 to 1h54) on average for each use of 3D video games (alone or networked), immersive games with goggles or headsets (alone or networked) and outdoor AR games. The average time was shorter for the other applications although still greater than one hour.

Table 6. Type of devices associates to VR and AR uses for adults and children by context (professional vs private).

Type of Applications	Adults-Professional Uses	Adults-Private Uses	Children
AR or VR games in establishment open to public.		1 h 26 min	1 h 15 min
AR or VR video-games played alone	1 h 51 min		
Video games using HMD or Glasses played alone		1 h 06 min	1 h 09 min
Video games using HMD or Glasses played in network		1 h 33 min	1 h 37 min

(Continued)

Table 6. Continued

Type of Applications	Adults-Professional Uses	Adults-Private Uses	Children
Outdoor AR games (Pokemon go, Harry Potter Wizard Unite)		1 h 26 min	1 h 54 min
3D video-games (Nintendo, 3DS...) played alone		1 h 36 min	1 h 44 min
3D Video games (Nintendo, 3DS...) played in network		1 h 38 min	1 h 35 min
3D immersive room/ CAVE		1 h 24 min	1 h 06 min
Health and rehabilitation applications	1 h 24 min	1 h 21 min	1 h 19 min
Application for design, maintenance or repair	45 min		
Application for education and training	53 min		
Application for stock management	1 h 27 min		

Self Reported Health Effects

In terms of health consequences, 29% of adults and 30% of children report experiencing symptoms either during or after exposure to VR or SR. Adults and children spontaneously mentioned dizziness (35% and 38%, respectively) and headaches (26% and 32%, respectively). Nausea was more frequently reported by adults (24% vs. 11% by children), while eye pain was more frequently reported by children (30% versus 19% by adults). Symptoms mainly appear during or immediately after exposure and disappear very quickly afterwards, with the exception of headaches and visual fatigue, which seem to persist more over time. Adults with both private and professional use reported proportionately more symptoms (49%) than respondents with only personal (24%) or occupational (23%). On the other hand, adults using VR or AR exclusively were less likely to experience symptoms (respect 17% and 24%) than those reporting use of both technologies (39%). When a list of 11 symptoms (headaches, dizziness, visual fatigue, disorientation, nausea, paleness, sweating, falls, vomiting, drowsiness, and trauma) was presented to participants, 50% of the adults and 41% of the children reported having experienced at least one of these (Table 7).

The types of use and technologies used seem to be determining factors in the occurrence of symptoms. Indeed, we found that self-reported symptoms appeared more often following the use of a headset dedicated to VR (29% of adults and 30% of children) and with a headset or connected glasses for AR, especially among children (43% of children and 22% of adults).

Table 7. Self-reported impact of VR/AR exposure on health by populations.

	Adults, Professional Use Only (n = 83)	Adults, Professional and Private Use (n = 164)	Adults, Private Use Only (n = 529)	All Adults (n = 776)	Children (n = 122)
Visual fatigue	15%	20%	15%	16%	19%
Headache	7%	35%	16%	18%	16%
Nausea	6%	23%	12%	14%	5%
Vomiting	4%	7%	2%	3%	2%
Pallor	2%	12%	5%	6%	7%
Sweating	7%	13%	4%	6%	4%
Diziness	17%	16%	18%	17%	14%
Disorientation	14%	19%	15%	15%	11%
Drowsiness	1%	6%	1%	2%	2%
Fall	7%	9%	3%	5%	2%
Collision	2%	7%	1%	2%	1%
Nervousness, irritability	-	-	-	-	2%

The pre-existence of disorders seems to predispose to the experience of symptoms when exposed to AR/VR. Indeed, adults who reported suffering from daily problems such as motion sickness, migraines, balance disorders, dizziness and hearing problems are more likely than others to experience symptoms during or after exposure to VR or AR, whether they are adults (80% vs. 60%) or children (59% vs. 31%).

Coping Strategies

To limit or eliminate the symptoms experienced, three main actions were reported : limiting the time of exposure (30% of adults and 32% of children), remaining seated (30% of adults and 32% of children) and spending time outdoors after exposure (26% of adults and 36% of children). For both adults and children, most of symptoms appear during or immediately after exposure and disappear immediately or within minutes of exposure. Symptoms that were reported as lasting longer were headaches, which disappeared only a few hours after exposure for 40% of adults and 57% of children, and visual fatigue, which disappeared only a few hours after exposure for 32% of adults and 26% of children.

CONCLUSION AND PERSPECTIVES

This study is the first one that identifies the characteristics of current users of VR or AR in the French population. Whether it concerns AR or VR, the average duration of use exceeds one hour for both adults and children. VR is used more in personal life than AR, while in the workplace, the two technologies are used in much the same way. In the private context, weekly use is mainly associated with video games, especially among children. The smartphone is the primary medium of use for adults, while it is the game console for children. However, adults, like children, use on average three different types of devices. In the professional context, weekly use is related to applications linked to training, health or stock management, and the smartphone is used

less in favor of the computer, video headsets or screens. In terms of health consequences, between one-third and one-half of users report having experienced symptoms during or following exposure to VR or AR, depending on how the measurement is conducted. The most common self-reported symptoms are dizziness and headache. Symptoms mainly appear during or immediately after exposure and disappear very quickly afterwards, with the exception of headaches and visual fatigue, which seem to persist more over time. The types of use and technologies used seem to be determining factors in the occurrence of symptoms. Thus, adults with both professional and private use, and those exposed to both VR and AR exhibit proportionally more symptoms than other users. Two types of interfaces are more often spontaneously associated with the occurrence of symptoms: headsets dedicated to VR and AR connected glasses, especially among children for the latter. However, symptoms were also evoked in association with the other types of interfaces evaluated, in a smaller proportion. Our results also suggest the possible effect of individual factors in the occurrence of symptoms. On the one hand, the pre-existence of disorders such as motion sickness, migraines, balance disorders and vertigo, and hearing disorders are proportionally accompanied by more symptoms experienced by VR/AR users. On the other hand, certain groups of users appear to be more sensitive, in particular women and young adults. Limiting exposure time, sitting and spending time outdoors are the main actions taken by users to prevent or eliminate these symptoms. These results, together with a review of the literature, provided the sound basis for the recommendations published by the French Agency for Food, Environmental and Occupational Health & Safety (Burkhardt, Attia, Behar-Cohen et al. 2021; ANSES, 2021).

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