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Oral vs. Touch Interaction for Cognitive Assessment: Acceptance and Perceived Usability by Senior Adults

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Abstract: There is a digital divide between senior adults and the general population because of the disparity in access and usage of digital technologies, including the internet and modern devices, often stemming from factors like age, familiarity, and socioeconomic status. Yet, technology is increasingly penetrating the healthcare sector in areas such as screening, diagnosis, treatment, and follow-up. This study focuses on investigating how older adults perceive the introduction of new devices in the screening and diagnosis of cognitive impairment. For this, a perception study was carried out involving 25 senior adults, 16 women and 9 men, aged between 60 and 93 years, living in the Vigo area, Spain. First, the perception and acceptability of popular technological devices were evaluated by means of the technology acceptance model. Then, participants' perceptions about the use of smart speakers and tablets for cognitive evaluation were analyzed, both before and after interacting with such devices. Finally, the perception of their caregivers about these tools was also studied. These instruments were found to be useful and enjoyable by older adults. More specifically, smart speakers were preferred by participants over traditional tests for detecting cognitive decline. Additionally, there were no significant differences in the perception of utility, ease of use, or enjoyment between tablets and smart speakers. Participants' caregivers also reported an overall positive perception about the introduction of these new tools for cognitive assessment. In any case, the study provided evidence to support the introduction of both tablets and smart speakers to interact with older adults, and more specifically, as a means to facilitate the early detection and screening of cognitive decline.

Keywords: smart speakers; smart devices; tablets; technology acceptance; senior adults; cognitive assessment; human–computer interaction

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1. Introduction

Information and communication technologies (ICTs) became facilitators of a large portfolio of services, devices, and applications aimed at improving people's lives. The use of ICT for neuropsychological assessment brings with it some relevant advantages [1], such as the standardization of administration procedures, greater accuracy in the presentation of response times and latencies, simpler and less error-prone data collection, and the possibility of capturing and monitoring dynamic indicators like cognitive markers such as writing time latency [2] or other non-cognitive indicators such as gait patterns [3]. By facilitating the administration of tests digitally or via online applications, ICT can also support better randomization of stimuli presentation across repeated administrations with the generation of varying stimuli.

Presently, we have at our disposal advanced data analysis models that allow us to take advantage of the information collected during the interaction with users to evaluate their cognitive capacity. One of the most prominent approaches in this field is machine learning, which is considered a branch of artificial intelligence that focuses on creating computing solutions that do not require task-specific programming [4], but are able to learn by training test cases or data, allowing the program to acquire knowledge and improve its performance based on accumulated experience. Currently, these machine learning-based analytics techniques are being increasingly used [5,6]. In the field of cognitive health, machine learning is complemented with advanced statistical techniques (e.g., multi-variate linear regression, logistic regression, classification and regression trees (CART), etc.) to infer users' cognitive abilities from their interaction with different types of technological tools, such as tablets or smart speakers. These techniques are also combined with other advanced analytical and prediction systems, such as neural networks [7] and item response theory [8].

Additionally, the use of intelligent conversational agents hosted by tablet computers or smart speakers is an emerging field of research, with the few published studies mostly quasi-experimental, and both their validity and reliability are rarely estimated. Despite this, recent literature points in favor of the use of conversational agents in support of patients suffering from mild cognitive impairment (MCI) [9,10]. In other words, intelligent agents become an element that, at least in principle, supports the introduction of tablets and smart speakers as the interaction devices of choice to provide assistance and support to senior adults, exploiting their intuitive and simple interaction capabilities.

In this context, the digital divide between senior adults and the general population represents a significant disparity in access to and utilization of digital technologies, particularly the internet and modern devices like smartphones, tablets, and smart speakers. This divide is primarily driven by factors related to age, as older individuals may have grown up during a time when such technologies were less prevalent or were not a part of their education [11]. Additionally, socioeconomic status can play a role, as seniors from lower-income backgrounds may face barriers in obtaining the necessary equipment and internet access [12]. Apart from limiting the opportunities for seniors to access critical services, connect with loved ones, and participate in the digital aspects of modern life, the digital divide may generate negative perceptions about new technological services and devices, which in turn may compromise some of the benefits expected from the introduction of technology in healthcare settings [13,14].

We can find in the literature some developments in oral and touch interactions for senior adults in cognitive assessment technologies. For example, [15] focuses on the use of cognitive interaction systems (CISs) to enhance the quality of life for older adults, while [16] aimed to develop performance evaluation measures for touch-based target selection difficulties in senior adults. Additionally, the use of virtual environments, such as non-immersive exergames and immersive virtual reality environments, has shown potential for assessing cognitive capabilities in elderly individuals [17]. Furthermore, a robotic platform was developed to conduct cognitive orientation assessments for the elderly, using natural language processing to evaluate user responses [18]. Finally, an analysis of older users' experience with portable electronic devices highlighted difficulties with finding and configuring settings, as well as issues with keyboard, font size, and touchscreen interactions [19].

Recent studies have also explored technology acceptance models applicable to senior users. Among them, Ref. [20] proposed a new conceptual framework for technology acceptance targeted at older Korean adults living in rural areas, finding significant positive paths from external controls, attitudinal beliefs, and cognitive health to internal abilities. Ref. [21] discussed an online mapping technology (OMT) acceptance model for older adults, finding that facilitating conditions, compatibility, and self-satisfaction positively influenced the perceived ease of use and perceived usefulness of OMT. Ref. [22] compared frail, prefrail, and robust groups to find that gerontechnology self-efficacy, health contexts and abilities, and attitudinal factors significantly affect intentions to use daily living assistive technologies. Ref. [23] collected a systematic literature analysis that served to identify factors influencing older adults' use of sports technology, including intention, perceived ease of use, perceived usefulness, and attitudes. These studies provide insights into technology acceptance among senior adults and can inform the development of targeted interventions and education programs.

The first field studies carried out by the atlanTTic Research Center at the University of Vigo in collaboration with the main socio-health entities in the region provided initial evidence on the psychometric validity of this approach to cognitive evaluation and its pertinence to assess different relevant aspects related to cognitive decline. These studies were carried out by means of pilots involving more than 150 participants, in which two instruments were used. The first one consists of three serious games running on a tablet computer and is aimed at assessing episodic memory, executive functions, and semantic memory, which are the main cognitive markers of MCI and dementia [24]. These games are based on psychometrically validated pen-and-paper tests, but provide a more interactive and motivating environment than their classical counterparts (i.e., the California Verbal Learning Test [25], the Rotor Pursuit Test [26], and the Pyramids and Palm Trees Test [27], respectively). The second tool is a cognitive impairment detection agent called DigiMoca [28]. This tool consists of an intelligent conversational agent running on a smart speaker that behaves as an adaptation of the telephone version of the classic MoCa test (T-MoCa [29]), which evaluates attention, concentration, memory, language, abstraction, calculation, and orientation.

No matter the advantages that may be brought by the incorporation of state-of-the art technological devices in cognitive screening for dementias, it is essential to investigate the perception of users when using them, as this aspect is instrumental to investigating the acceptance and, ultimately, the feasibility of the introduction of these technologies in actual clinical settings. Knowing the experience and opinions of users can also provide invaluable information to improve and adapt technological tools to their specific needs, allowing us to identify possible barriers or challenges that hinder the successful implementation of these tools, and thus be able to take appropriate measures to overcome them. This is particularly important in the case of senior users. A person-centered approach helps to ensure that cognitive screening technologies are more accessible and user-friendly for the older population, enabling accurate early detection, providing more comprehensive monitoring of their cognitive status, and providing appropriate technological support to their daily activities and to maintain their cognitive reserve.

This study relies on the technology acceptance model (TAM) [30] to assess user acceptability and perception. This instrument is a theoretical model developed in the field of research on technology adoption and acceptance and is based on the premise that the acceptance and use of technology are mainly influenced by individuals' perceptions of its usefulness and ease of use, variables that eventually determine an individual's attitude towards technological devices.

TAM is administered by means of a five-point Likert scale questionnaire and aims to capture information on the perception and application of technologies in daily life. The Likert scale is a widely used tool for measuring attitudes and perceptions, as it allows respondents to express their opinions on an intuitive scale, offering a structured way to gauge perceived utility, ease of use, and enjoyment. The five-point Likert scale provides a range of responses sufficient for capturing subtle differences in senior users' perceptions.

In this study, the target technologies are digital cognitive tests performed on a tablet and a smart speaker. Participating subjects complete a TAM questionnaire before and after the use of the two instruments under study. The information collected is used to evaluate three main aspects, namely perceived usefulness (PU), which refers to the degree to which a person believes that the use of a particular technology will improve their performance when doing a specific activity; perceived ease of use (PEOU), which indicates to what extent a person believes that, by using a technological system, they will perform their tasks with less effort; and finally, perceived enjoyment (PE), which refers to the degree to which a person finds an activity to be pleasant or enjoyable when carried out with the support of a certain technology. These perceptions influence the individual's attitude toward technological tools, their intention to use them, and ultimately, their actual usage patterns.

Thus, the main objective of this research is to conduct a comparative study on the acceptability of the two tools mentioned above, a tablet and a smart speaker hosting Panoramix and DigiMoca, respectively, by regular attendees of a day care center for seniors. The study will focus on assessing how users perceive, accept, and enjoy each of these tools in a day center context and how they perceive them in relation to their classical counterparts, namely pen-and-paper tests in the case of Panoramix and person-to-person interviews in the case of DigiMoca. As a secondary objective, information on the perceived acceptability of the day center professionals involved will also be gathered.

2. Materials and Methods

This study involved a total of 25 volunteers, 16 women and 9 men, aged between 60 and 93 years, living in the Vigo area, Spain, with a mean age of 79.80 and a standard deviation of 7.842 years. In addition, the scores of each of the participants on the Barthel scale [31] were collected. This scale measures autonomy for activities of daily living, with a maximum score of 100 indicating the maximum degree of independence. Thirteen participants scored 100 (i.e., completely independent), one person scored 95 (i.e., low dependence), ten people scored between 61 and 90 (i.e., moderate dependence), and the remaining participant scored 60 (i.e., severe dependence).

Participants were recruited at the Parque Castrelos day care center; all of them signed an informed consent form approved by the Research Ethics Committee of Galicia, which also approved this study (protocol 2023/15 [32]), thus ensuring compliance with the applicable ethical regulations and the protection of the privacy of the participants according to the EU's General Data Protection Regulation.

In order to define the characteristics of the sample, the initial inclusion and exclusion criteria applied are enumerated below:

1. Inclusion factors:
    - Persons without cognitive impairment (GDS 1), very mild cognitive impairment (GDS 2), and mild cognitive impairment (GDS 3).
    - Persons over 65 years of age.
    - Users of Parque Castrelos day center.
2. Exclusion factors:
    - Persons unable to consent to the study.
    - Persons with moderate or advanced cognitive impairment (GDS $\geq$ 4).
    - Individuals with an active psychiatric condition.
    - Individuals with severe hearing or vocal impairments.
    - Persons declaring technological aversion or phobia.
    - Illiterate individuals.

All participants were carefully selected according to the previously mentioned criteria. GDS refers to the Global Deterioration Scale [33], a popular instrument for the assessment of primary degenerative dementia and the delineation of its stages. It was considered convenient, upon recommendation of the day center, to include two additional subjects who had a GDS level within the inclusion criteria but whose ages were lower than the 65 years initially proposed (i.e., 60 and 62 years old). Eventually, 16 people classified as GDS 1 or GDS 2, which indicates normal cognitive function or with very slight impairment, participated in the study, together with 9 people classified as GDS 3, which corresponds to mild cognitive impairment (cf. Table 1).

The selection and classification of participants based on the GDS scale was carried out by staff external to the study, specifically the multidisciplinary team of Parque Castrelos day care center, which is composed of a psychologist, a social educator, a physiotherapist, and the coordinator of the team of geroculturists.

Table 1. Participants' GDS level. Most participants (11) exhibited very slight deterioration, while 9 presented mild cognitive impairment and 5 presented normal cognitive function.

	Frequency	**% of Subjects**	**Cumulated %**
GDS 1	5	20.0	20.0
GDS 2	11	44.0	64.0
GDS 3	9	36.0	100.0
Total	25	100.0	

All participants had already undergone at least one classical cognitive assessment process based on pencil-and-paper tests and, more specifically, CLVT's Spanish version and the card version of Pyramids and Palm Trees. These instruments were the ones that would be administered by means of a tablet computer. Consequently, during the pilot, information would also be gathered to compare perceptions about classical and digital tests. However, this was not the case for T-MoCa's smart speaker version, and no participant had previous experience with only-verbal cognitive assessments. To guarantee a similar baseline for both devices, participants were also tested with T-MoCa before interacting with tablets and smart speakers. This also served as confirmation of participants' GDS level.

Each subject participated in four individual weekly sessions, carried out over a period of four weeks. For logistic reasons (i.e., only a small number of smart speakers were available), the subject sample was randomly divided into two groups (cf. Table 2):

Group 1 composed of 13 people, 4 of whom were men and 9 were women. Within this group, 9 participants were classified as GDS 1 or 2, while 4 of them presented mild cognitive impairment (GDS 3). These participants started their pilot sessions by interacting with the smart speaker.

Group 2 composed of 12 people: 5 men and 7 women. In this group, 7 users were assessed as GDS 1 or 2, and 5 as GDS 3. Participants in this group started the pilot sessions with MoCa's telephone version (T-MoCa).

Table 3 summarizes the relations between group and gender variables. During the first session, the perception and acceptability of popular technological devices were evaluated by means of the TAM questionnaire. Once the survey was completed, T-MoCa or its smart speaker version was administered, depending on the subject's assigned group (i.e., one group was evaluated using T-MoCa and the second group using DigiMoca). All participants (i.e., both groups) were eventually evaluated with both T-MoCa and its digital counterpart, and T-MoCa outcomes served as a golden standard. As T-MoCa and its smart speaker version are conceptually equivalent, participants were administered T-MoCa and DigiMoca in separate sessions to minimize possible learning effects.

Table 2. Participants' group distribution. For logistical reasons, participants were distributed into two groups of roughly the same size.

	GDS 1	**GDS 2**	**GDS 3**	**Total**
Group 1	2	7	4	13
Group 2	3	4	5	12
Total	5	11	9	25

Table 3. Participants' gender distribution. Gender distribution is comparable with the actual gender distribution of the senior population in Galicia.

	Female	**Male**	**Total**
Group 1	9	4	13
Group 2	7	5	12
Total	16	9	25

During the second session, each participant was administered the cognitive assessment solution not experienced in the first session, that is, group 1, which was previously administered T-MoCa, was assessed with DigiMoca, while group 2, which did not interact with T-MoCa during the first session, was assessed by means of a smart speaker. This second session took approximately 15 min.

During the third session, all participants interacted with a tablet computer to play the Panoramix serious games.

Finally, in the fourth and last session, the instrument hosted by the smart speaker was administered for a second time to all participants, and the session was completed with a post-pilot acceptability analysis using the TAM model discussed above.

IBM's statistical package SPSS v. 27 [34] was used to perform statistical analysis. Descriptive statistics and frequencies were obtained for demographic data (i.e., gender, GDS level, group, and age variables) and questionnaire responses. The descriptive statistics utilized helped to summarize and describe the perceptions gathered, as they provide a clear understanding of the central tendency, variability, and distribution of responses, enabling us to identify patterns and trends in the perceptions of senior adults regarding both devices. For the analysis of TAM responses, a reliability analysis was also performed using the Cronbach's alpha coefficient (α_C). This coefficient provides a measure of reliability that indicates the internal consistency of a set of items in a questionnaire [35]. It makes it possible to evaluate the reliability of the responses and to ensure that items in the questionnaire consistently measure the variable intended to be measured.

In addition, TAM items were grouped into three dimensions: (1) perceived usefulness (PU), (2) perceived ease of use (PEOU), and (3) perceived enjoyment (PE). Next, the mean of each dimension was calculated, and a visual grouping was carried out with the aim of facilitating data visualization and subsequent analysis. Finally, as one of the aims of this study was to detect different perceptions about technology before and after interacting with the devices mentioned, a study of the normality distribution was carried out using the Wilcoxon rank test for related samples of less than 50 participants [36]. In this context, this test aids in verifying whether the responses collected from senior adults adhere to a normal distribution, which is essential for conducting our statistical analyses accurately. The choice of using the Wilcoxon rank test for smaller samples ensures the assumption of normality for subsequent statistical analyses. It is most relevant to validate this assumption, especially with smaller sample sizes, to avoid biased conclusions or inaccurate interpretations of the data. This made it possible to decide between parametric and nonparametric tests to analyze the existence of significant differences before and after administration of the technological instruments.

The combination of the Likert scale for perceptions, descriptive statistics for summarizing data, Cronbach's alpha coefficient for reliability analysis, and Wilcoxon rank test for verifying data normality facilitated a comprehensive analysis of perceptions and acceptance before and after exposure to tablets and smart speakers among senior adults. They provided valuable insights into how their opinions change following interaction with these technologies, aiding in understanding preferences and potential barriers to adoption.

For the analysis of acceptability and usability from the perspective of health practitioners at the day center, the Post-Study System Usability Questionnaire (PSSUQ) was utilized. This questionnaire includes a total of 19 items that collect information on the general perceptions of usability and usefulness of technology. Responses correspond to a Likert scale with 7 options, reflecting a range of perceptions from 1 (strongly disagree) to 7 (strongly agree). PSSUQ collects data on three dimensions of interest, namely system usability (items 1–8), information quality (items 9–15), and interface quality (items 16–18) [37].

This questionnaire was applied to three professionals from different fields who were present during the administration of the smart speaker-based cognitive evaluations. As pointed out above, these professionals are part of the multidisciplinary team of the Parque Castrelos day center, and include a therapist, a social educator, and a psychologist, aged between 28 and 50 years. In this study, due to the limited size of the sample and the fact that all three participants already had extensive experience with tablet computers, only information on their perceptions of smart speakers was gathered.

3. Results

As discussed above, a reliability analysis of TAM responses was performed using the Cronbach's alpha coefficient. The result obtained, $\alpha_C = 0.891$, confirms the high reliability of the TAM survey used.

3.1. Frequency of Use and General Perception of Technological Devices

First, an analysis of the frequency of use of technological instruments and the general perception of technology was carried out. As depicted in Figure 1, television is the most used technological tool ($M = 4.24$, cf. Table 4); 52% of respondents (13 subjects) reported frequent use of the television, while 36% (9 individuals) used this device intensively.

Table 4. Frequency of use of technologies. Descriptive statistics.

	TV	Mobile	Internet	Social Net.	Tablet	Computer	E-Mail
Mean	4.24	2.72	1.76	1.36	1.24	1.24	1.12
Std. Dev.	0.663	1.429	1.422	0.952	0.663	0.523	0.332

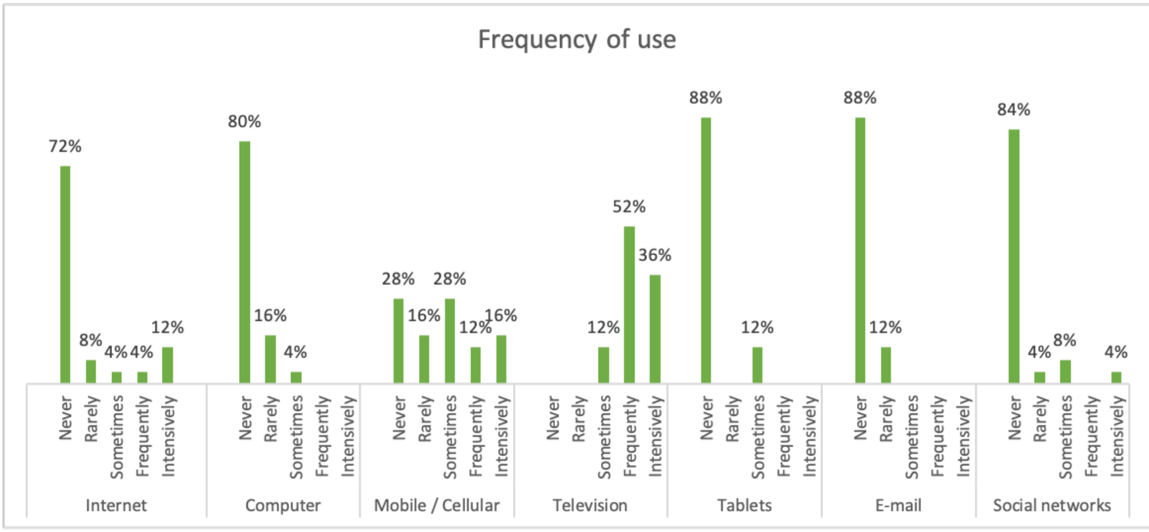

Figure 1. Frequency of use of technologies. The most popular technologies used by participating senior adults were mobile phones and television sets.

In contrast, tablet computers ($M = 1.24$) along with e-mail ($M = 1.12$) and social networks ($M = 1.36$) were the tools least used by participants in this pilot study, with a high percentage of people claiming that they never utilized them. More specifically, 88% never used a tablet or e-mail, and 84% never used social networks. In relation to computers ($M = 1.24$) and the internet ($M = 1.76$), 80% and 72%, respectively, claimed that they never used them. On the other hand, as shown in Figure 1, cell phone usage ($M = 2.72$) presents greater variability due to the fact that the sample is dispersed along all frequency of use ranges.

Despite the fact that participants reported a low frequency of use of most technological devices with the exception of television ($M = 4.24$), 52% of them perceived technology as very useful, while 40% considered it to be quite useful (cf. Figure 2). In addition, 88% of respondents admitted to enjoying using technological devices very much (60%) or quite a lot (28%). In terms of ease of use, 44% of subjects perceived technology as very easy to use in general, while 32% found it quite easy to use.

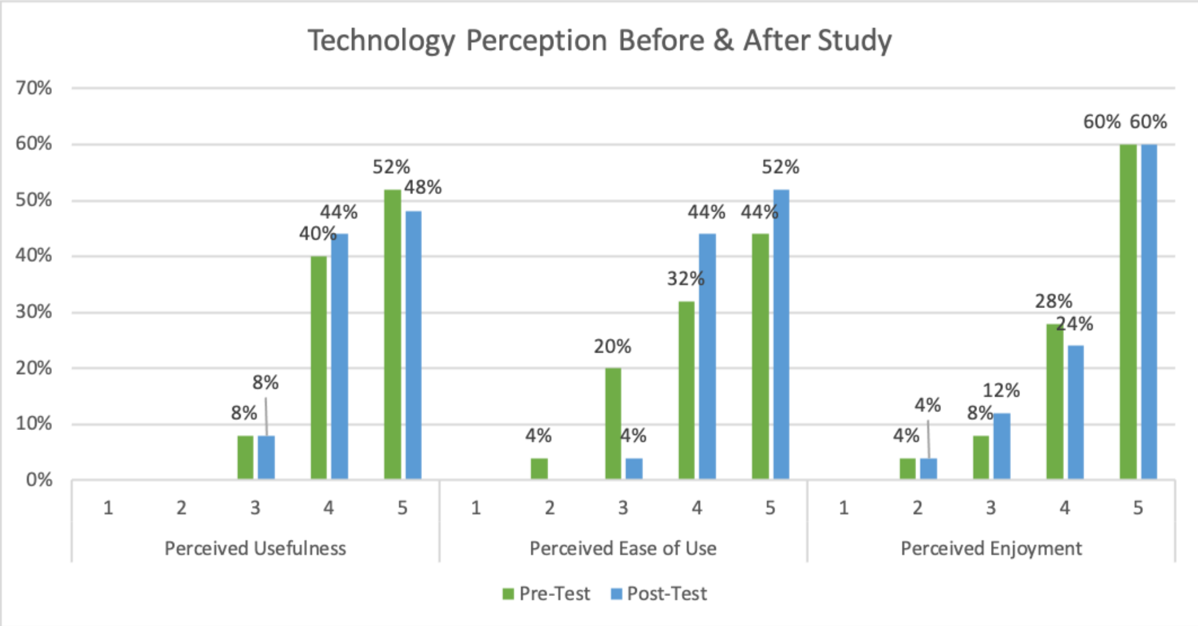

Figure 2. Technologies and senior adults: perception of usefulness, ease of use, and enjoyment before and after the pilot study (1 = lowest value: lowest perception of usefulness, ease of use, and enjoyment/ 5 = highest value: highest perception of usefulness, ease of use, and enjoyment).

On the other hand, when comparing the perception of technologies before and after interacting with tablets and smart speakers (cf. Table 5), it can be observed that the mean values are very close, and the Wilcoxon test indicates that there are no significant differences in any of the dimensions (PU, PEOU, PE) before and after interacting with the devices (cf. Table 6). Despite this, as can be seen in Figure 2, perceived ease of use is the only dimension with a clear trend towards improvement. Specifically, it can be observed that 32% of participants considered the technological devices to be quite useful instruments before the intervention, and after interacting with them, this percentage increased to 44%. In addition, an increase in the maximum score of the scale in this dimension (perceived ease of use) is evident, rising from 44% before the study to 52% after the study.

Table 5. Perception of usefulness, ease of use, and enjoyment. Descriptive statistics.

	Pre-Test		**Post-Test**	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
PU	4.22	0.630	4.24	0.663
PEOU	3.94	0.928	4.20	0.661
PE	4.22	0.925	4.16	0.943

Table 6. Wilcoxon signed-rank test results (pre-test vs. post-test).

	PU	**PEOU**	**PE**
Z-test	−0.263	−1.365	−0.048
Asympt. tails	0.793	0.172	0.962

3.2. Users' Perceptions of Smart Speakers

In relation to the interaction with a smart speaker, significant differences ($p < 0.05$) were observed in the three dimensions of the TAM perception survey before and after the study (cf. Table 7).

Table 7. Wilcoxon signed-rank test results (pre-test vs. post-test) for smart speakers.

	PU	PEOU	PE
Z-test	−3.994	−4.146	−4.172
Asympt. tails	0.000	0.000	0.000

Although it is true that a large majority, specifically 80%, of the participants were unaware of this type of technology before the pilot, once they interacted with it, a clearly positive trend can be observed, with most participants tending to rate it with high scores of 4 or 5 on the Likert scale (cf. Figure 3). This can be observed in the post-test averages, which present high scores in relation to the three dimensions, indicating a positive perception in terms of its usefulness ($M = 4.14$), ease of use ($M = 4.18$), and enjoyment ($M = 4.16$) (cf. Table 8).

Table 8. Smart speakers. Descriptive statistics.

	Pre-Test		Post-Test	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
PU	1.40	1.837	4.14	0.757
PEOU	0.82	1.725	4.18	0.840
PE	0.80	1.683	4.16	0.898

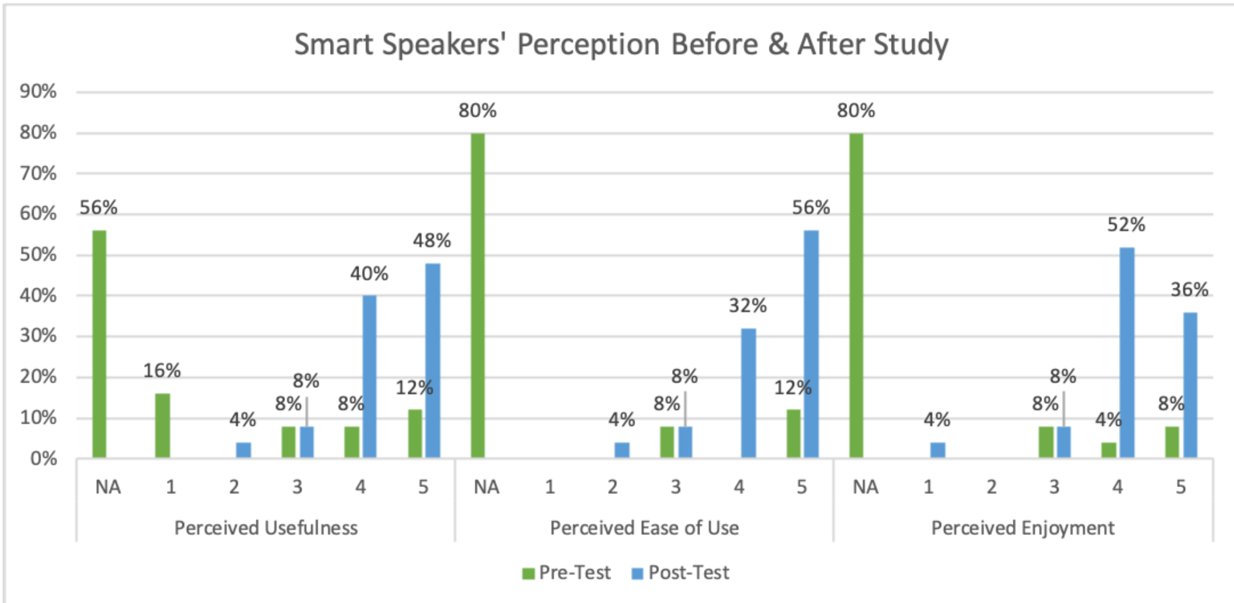

Figure 3. Smart speakers: perception of usefulness, ease of use, and enjoyment before and after the pilot study (1 = lowest value: lowest perception of usefulness, ease of use, and enjoyment/5 = highest value: highest perception of usefulness, ease of use, and enjoyment).

With respect to the perception of usefulness, before interacting with the smart speaker, 44% of subjects knew about this type of device but admitted to never having used it. Among them, four people (16%) perceived smart speakers as not useful at all, but this dropped to 0% after the experience. Five users (20%) already considered them to be quite useful, with scores of 4 and 5 on the Likert scale. These values increased considerably to 40% (10 of 25 participants) who rated smart speakers with a score of 4 (i.e., quite useful), while 48% (12 individuals) rated them with a score of 5. On the other hand, two participants (8%) opted for an intermediate score of 3 before and after administration, and only one person considered them not very useful, with a score of 2 (cf. Figure 3).

In relation to the perceived ease of use, 80% of the sample had never used a smart speaker and therefore could not rate its ease of use before the study. Only five people had this experience; three of them (12%) rated smart speakers with a score of 5, considering them very easy to use, and two people (8%) considered them moderately easy to use, with a score of 3. After interacting with the speakers, these values clearly improved, since most users (56%) rated them as very easy to use, and 32% considered them quite easy to use. On the other hand, 8% of users kept scoring speakers with a 3 on the Likert scale, and only one participant did not consider smart speakers as particularly easy tools to use.

Finally, when questioned about perceived enjoyment, the five people who previously used smart speakers rated them as moderately fun (two individuals), while the other three perceived them as quite or very entertaining. After the experience, 52% of participants enjoyed them quite a lot (score of 4), and 36% provided a score of 5 out of 5. On the other hand, the two subjects who rated smart speakers with a 3 confirmed this score post-test, while only one person admitted not having enjoyed the device at all.

3.3. Users' Perceptions of Tablet Computers

As in the case of smart speakers, non-parametric analyses of related samples indicate significant differences in the perception of participants in the three dimensions analyzed before and after interacting with tablet computers to play serious cognitive games ($p < 0.05$, cf. Table 9).

Table 9. Wilcoxon signed-rank test results (pre-test vs. post-test) for tablet computers.

	PU	PEOU	PE
Z-test	−4.212	−4.276	−4.334
Asympt. tails	0.000	0.000	0.000

In addition, post-test averages present fairly high scores, indicating a favorable perception in all three domains of perceived usefulness ($M = 3.80$), perceived ease of use ($M = 3.98$), and perceived enjoyment ($M = 4.08$) (cf. Table 10).

Table 10. Tablet computers. Descriptive statistics.

	Pre-Test		Post-Test	
	Mean	Std. Dev.	Mean	Std. Dev.
PU	0.60	1.291	3.80	0.890
PEOU	0.32	1.145	3.98	0.797
PE	0.32	1.145	4.08	1.077

When performing the comparative analysis before and after the interaction with a tablet, it was observed that the majority of users (92%) never used similar tools and were unaware of their operation, and 16% were aware of the existence of serious games on tablets but had never played them (cf. Figure 4). The fact that 16% of users were aware of the existence of serious games on tablets but had never played with them stems from the difference between 92% of users not reporting their perceived ease of use or perceived enjoyment and 76% of users not reporting their perceived usefulness. The difference, 16%, who perceive a degree of usefulness but have not utilized those devices corresponds to people aware of the technological instrument, in most cases from other family members or peers attending the daycare center, but who have never interacted with it. This was confirmed explicitly by participants in this group.

Regarding the perception of usefulness after the study, 40% of participants rated this device with a score of 4, indicating that they consider it a fairly useful technological resource, and 32% perceived it as very useful (i.e., a score of 5). However, 28% rated tablets' usefulness with a more conservative score of 3. In any case, these results reflect a positive perception of the usefulness of serious games. It should be noted that, before the application of the test, 12% of participants who were aware of this type of instrument rated them with a score lower than 3, but this perception changed after the test was administered, since no scores lower than 3 were obtained.

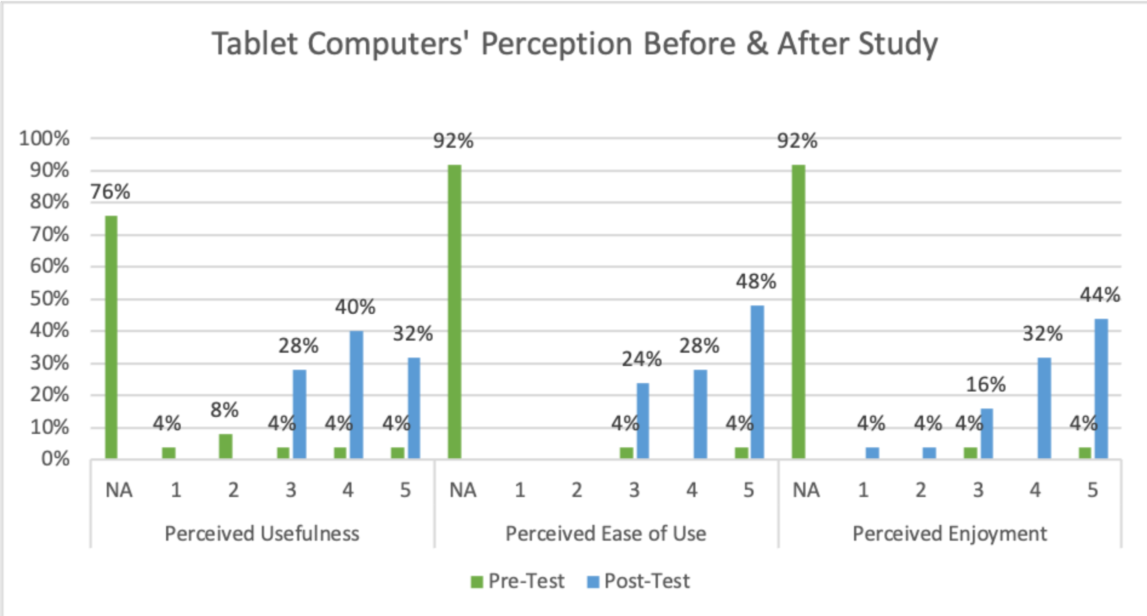

Figure 4. Tablet computers: perception of usefulness, ease of use, and enjoyment before and after the pilot study (1 = lowest value: lowest perception of usefulness, ease of use, and enjoyment/5 = highest value: highest perception of usefulness, ease of use, and enjoyment).

In relation to the perceived ease of use dimension, results show that, after the study, 48% of subjects considered this tool to be very easy to use, while 28% rated it as fairly easy to interact with (score of 4), and 24% as moderately easy (score of 3). On the other hand, in the analysis of perceived enjoyment, it is observed that the majority of participants, specifically 44%, perceived the activity as most entertaining. Likewise, 32% provided a score of 4, and 16% rated it with a 3.

3.4. Tablets vs. Smart Speakers: Comparative Analysis

In relation to the preference between smart speakers and classical interaction by means of a face-to-face interview or telephone conversation, participants provide responses that do not let us extract clear conclusions due to their limited statistical significance ($p = 0.050$), which in turn reflect a broad range of perceptions for a small population and subtle differences. In any case, the average score is 2.84 (cf. Table 11), which corresponds to a score that indicates that there is no clear preference between a smart speaker and traditional ways of interaction. Specifically, 28% (seven people) indicated that they did not prefer a smart speaker when compared to person-to-person communication (score of 2 out of 5). On the other hand, six of the participants (24%) expressed a more moderate stance, assigning a score of 3. In contrast, eight participants expressed a clear preference for the smart speaker option, five of them (20%) assigned a score of 4, and three respondents (12%) rated it with the maximum score of 5 points, indicating that they consider smart speakers as a highly preferable tool compared to a traditional interaction when performing cognitive assessment (cf. Figure 5).

Table 11. Comparative analysis. Descriptive statistics.

	Smart Speaker vs. Classical Test		Smart Speakers vs. Tablets	
	Smart Speaker	**Classical Test**	**Smart Speaker**	**Tablet**
Mean	2.84	3.52	2.48	3.40
Std. Dev.	1.281	1.262	1.159	1.472

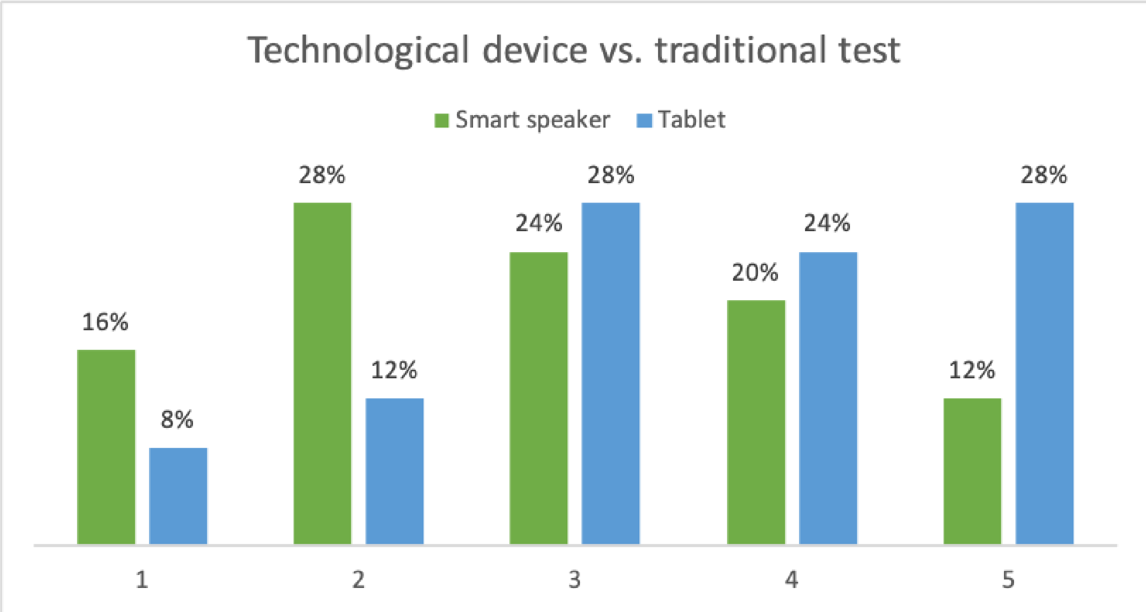

Figure 5. Technical devices vs. classical tests (i.e., interview/telephone vs. smart speaker and pen-and-paper vs. tablet).

Regarding the preference between tablets hosting videogames and traditional pen-and-paper tests, it can be observed that there is a slightly more defined trend to prefer the administration of games by means of a tablet than in the case of smart speakers compared to traditional tests. The mean score obtained in this case is 3.52 (cf. Table 11), which suggests that participants consider that the introduction of tablets offers certain advantages compared to traditional tests. Specifically, 28% (seven individuals) provided a score of 5, reporting a clear preference for the tablet option, and six people (24%) rated tablets with a score of 4. Only 8% favored pen-and-paper tests, and 28% did not express a definite preference, with a score of 3 out of 5.

Finally, when comparing the preference between smart speakers ($M = 2.48$) and tablets ($M = 3.40$), differences were found with a value of $p = 0.043$ (cf. Table 12). These data suggest that there is some tendency to prefer the tablet hosting serious games over the smart speaker option, although this preference is barely statistically significant.

Table 12. Wilcoxon signed-rank test results. Comparative analysis.

	Tablet vs. Pen-and-Paper/Smart Speaker vs. Interview	Tablet/Smart Speaker
Z-test	−1.956	−2.028
Asympt. tails	0.050	0.043

In the case of tablets, seven individuals (28%) show a clear preference for this tool, with a score of 4 out of 5, and another 28% do so with the highest score of 5 (cf. Figure 6). This contrasts with the 24% and 4%, respectively, of users preferring the smart speaker, with most of them (52%) leaning towards a lower score of 2.

The average values of the dimensions assessed by the TAM survey (cf. Table 13) show that the values of perceived usefulness ($M = 4.14$), perceived ease of use ($M = 4.18$), and perceived enjoyment ($M = 4.16$) are slightly higher in the case of smart speakers than in the case of tablets (i.e., $M_{PU} = 3.80$, $M_{PEOU} = 3.98$, and $M_{PE} = 4.08$), although again they cannot be considered statistically significant differences (i.e., $p_{PU} = 0.082$, $p_{PEOU} = 0.396$, $p_{PE} = 0.926$, cf. Table 14). Thus, we can conclude that there are no significant differences in the perception of usefulness, ease of use, or enjoyment for both approaches, although participants show a certain tendency to prefer the smart speaker option.

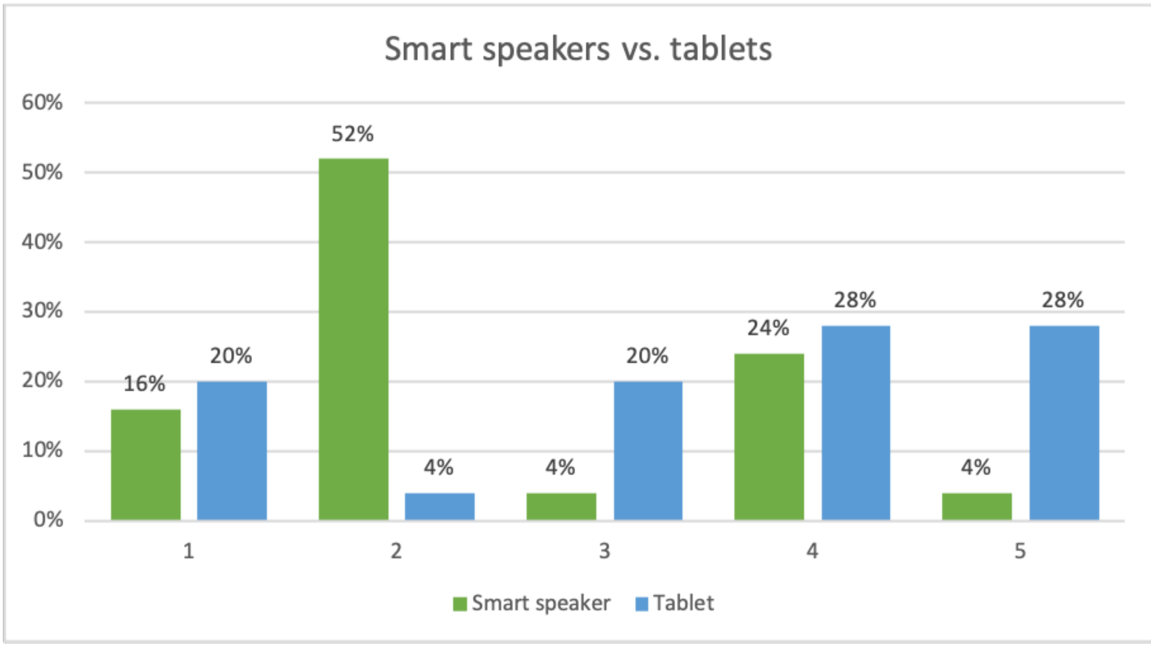

Figure 6. Users' perception of smart speakers when compared to tablets (1: least-preferred device; 5: most-preferred device).

Table 13. Participants' perceptions of smart speakers when compared to tablets. Descriptive statistics.

	Tablets		Smart Speakers	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
PU	3.80	0.890	4.14	0.757
PEOU	3.98	0.797	4.18	0.840
PE	4.08	1.077	4.16	0.898

Table 14. Wilcoxon signed-rank test results (post-test, smart speakers vs. tablets).

	PU	PEOU	PE
Z-test	−1742	−0.850	−0.092
Asympt. tails	0.082	0.396	0.926

3.5. Practitioners' Perceptions

The mean total score obtained was 4.41, with a standard deviation of 1.41 (cf. Table 15), indicating an overall positive score but with some variability in the responses. In relation to the dimensions, the usefulness of the system obtained an average score of 4.81, which suggests that the evaluators considered that smart speakers were useful overall as a tool to administer cognitive assessment. On the other hand, in relation to the quality of the information, the values obtained ($M = 3.93$) indicate that the quality provided by the smart speakers was considered moderate. Finally, with respect to the quality of the interface, a mean score of $M = 4.55$ was obtained, which suggests that the surveyed professionals perceived the interface as relatively good.

Table 15. Practitioners' perceptions about the usability and accessibility of smart speakers.

	N	Min.	Max.	Mean	Std. Dev.
Overall	3	2.83	5.53	4.41	1.41
Usefulness	3	3.13	6.43	4.81	1.70
Information quality	3	2.43	4.80	3.93	1.31
Interface quality	3	3.00	6.00	4.55	1.50

Practitioners also provided their perceptions in relation to the positive and negative aspects of smart speakers as cognitive assessment instruments, which confirmed the values provided when answering the questionnaire. All the information collected, especially the negative aspects, is valuable for further developing and optimizing the instrument since it allows the identification of areas where improvements and possible adjustments are necessary for a more effective introduction.

Among the positive aspects, it was noted that smart speakers facilitate the introduction of new technologies and dynamic learning, being considered useful and easy to use. In addition, it was emphasized that they provide clear and understandable information for users without sensory deficits. The novelty of the instrument was also perceived as attractive and interesting. Finally, its accessibility as a tool and its usefulness in the evaluation and detection of cognitive impairment were highlighted.

On the other hand, professionals identified some negative aspects that should be taken into account for the improvement of the instrument. All three contributors agree that response times should be extended since some users with cognitive impairments require more time to react to an automated voiced agent.

It was also pointed out that smart speakers are not adapted for users with hearing deficits. In addition, it was suggested to add the possibility of increasing the volume further, even adaptively, to facilitate access for people with hearing deficits. In addition, the need for a pre-assessment phase was pointed out to let subjects experience the interaction with the smart agent and thus familiarize them with the device prior to the actual cognitive evaluation session.

4. Discussion

The multifaceted perspectives of this work are examined below, encompassing senior adults' perceptions of the technologies utilized in this study, insights into health practitioners' and caretakers' viewpoints, as well as an analysis of the study's limitations.

4.1. Senior Adults' Perceptions

As might be expected, the results obtained in relation to frequency of use indicate that television is the most-used technological device among participants ($M = 4.24$). This phenomenon can be attributed to a number of factors, such as elders' poorer technological skills, lower purchasing power that impedes access to more advanced and expensive technologies, a lack of instructions and guidance to acquire technological skills needed for newer devices, a lack of knowledge and confidence in handling new technologies, as well as the persistence of more traditional habits. Television is often perceived as simpler and less overwhelming compared to newer technologies, which can have a steeper learning curve in a context where older adults have limited exposure to newer technologies during their formative years, so they may not have had the same opportunities to learn how to use smartphones or computers.

In addition, health-related barriers may hinder access to and learning of new technologies in this age group, while television has been a part of daily life for several decades, and many older adults are more comfortable with the technology with which they grew up. They may find it easier to use and navigate compared to newer devices, as television is typically more accessible for seniors who may have physical limitations or impairments that make using newer technologies, such as computers or tablets, more challenging.

On the other hand, participants' general perception about popular technologies before and after their participation in this study is quite positive, and no significant ad hoc or post hoc differences were found, suggesting that their participation in this study did not have a significant impact on their perception. Furthermore, the data gathered indicate that the lack of use of new technologies is not due to a lack of interest or negative perception, since they value them as very useful ($M_{pre} = 4.22$, $M_{post} = 4.24$), easy to use ($M_{pre} = 3.94$, $M_{post} = 4.20$), and enjoyable ($M_{pre} = 4.22$, $M_{post} = 4.16$). It can also be inferred that the low use of technologies in general by this sample of people over 65 is not due to a lack of interest or perceived difficulty; instead, it can be hypothesized that it is due to existing barriers to accessing them.

In the case of the smart speakers, the results obtained reflect significantly positive perceptions of participants towards them. Statistically significant differences were found before and after their administration, since participants had no prior knowledge of them. Despite the lack of initial information, the average perceived usefulness ($M_{PU} = 4.14$), perceived ease of use ($M_{PEOU} = 4.18$), and perceived enjoyment ($M_{PE} = 4.16$) were quite high, as the majority expressed a favorable perception in all three domains. These results indicate a positive perception of these devices among participants, despite the lack of previous familiarity with them.

As for tablet computers, statistically significant differences were also found in all three perception dimensions before and after interacting with them. As in the previous case, this is explained by the absence of previous experience due to the lack of knowledge of this type of device. However, once the interaction sessions were completed, the perception was very favorable, with averages similar to those obtained for smart speakers (i.e., $M_{PU} = 3.80$, $M_{PEOU} = 3.98$, and $M_{PE} = 4.08$). In conclusion, despite the fact that participants lacked previous experience and knowledge about tablet computers, the experience was positive for them, concluding that they are quite useful, easy to use, and entertaining.

When analyzing the differences between the two devices (i.e., smart speakers and tablets), the results show a preference for tablets. However, as can be inferred from average values, there are no statistically significant differences in perception, as evaluated by the TAM survey. Both are similarly rated as very useful with low significance values ($p_{PU} = 0.082$, $p_{PEOU} = 0.396$, $p_{PE} = 0.926$). However, when exploring the preference between both tools for cognitive assessment, a slightly significant trend was found in favor of playing games with a tablet ($M = 3.40$) compared to talking to a smart assistant hosted by a smart speaker ($M = 2.48$), with a significance value of $p = 0.045$. These results may be due to the more dynamic and interactive approach of game playing along with the favorable visual context it offers compared to the purely auditory approach of the smart speaker, which would result in a slight tendency to prefer videogames.

As for the comparison between interacting with a smart agent and the traditional face-to-face or telephone interview, no clear preference was found for one approach or the other ($M = 2.84$). However, in the case of the tablet-hosted videogames vs. pen-and-paper tests, there is a slight tendency in favor of the former ($M = 3.52$, $p = 0.050$). This suggests that participating users consider that the introduction of tablets offers certain advantages compared to traditional tests, which may be due to aspects such as the higher level of interactivity or the active role users play with this tool.

The favorable perceptions of both smart speakers and tablets suggest that these tools are well-received and considered suitable for use among senior adults. This positive reception implies that these technologies can potentially serve as effective tools for cognitive assessment and engagement within this age group. In addition, the study's findings, indicating perceived usefulness and added value compared to traditional approaches, highlight the potential benefits that smart speakers and tablets offer in cognitive assessment. This suggests that these modern technologies could provide advantages over conventional methods, possibly leading to more engaging and effective assessment techniques.

Moreover, the positive ratings for ease of use are especially relevant, particularly for older adults. The ease of interaction with these devices indicates that user-friendly interfaces are instrumental in ensuring successful engagement and positive experiences among senior adults. This aspect is especially relevant for technology adoption in this demographic, as ease of use directly relates to their satisfaction and overall user experience.

These positive perceptions also indicate a shift in cognitive assessment practices. Integrating user-friendly technology like smart speakers and tablets into assessment methods for senior adults may enhance engagement, accuracy, and the overall acceptability of such assessments. It also suggests the potential for these tools to be utilized in various cognitive training and intervention programs for older adults. In addition, the study's positive outcomes have broader implications for the acceptance of technology among aging populations, as it highlights that, with appropriate design considerations and user-friendly interfaces, modern technology can be embraced and utilized effectively by senior adults, challenging stereotypes about their reluctance to adopt new technologies. However, the findings also stress the importance of developing tailored technological solutions that cater to the unique needs and preferences of our elders. This requires designing intuitive interfaces, clear instructions, and functionalities that align with the capabilities and interests of older users.

4.2. Practitioners' Perceptions

Due to the limited number of practitioners participating in this study, although the results obtained are clearly positive, they cannot be considered to be statistically significant. However, a wider multicenter study performed by our team and that involved 24 professional caregivers [38] indicated that the overall usability perception from practitioners is generally positive, slightly under 6 on a 7-point scale, and never drops below 5 for any of the dimensions in Table 15, even if considering specific demographic groups based on gender, career field, and years of experience. In the mentioned extended study, with respect to practitioners' overall usability, we obtained an average value of 5.86 ± 1.24 with an internal consistency of ($\alpha_C = 0.95$) for all participants and all items, which did not significantly change depending on gender or career experience. When inquired about the perceived usefulness, the average rating was 5.96 ± 1.14 ($\alpha_C = 0.91$), which was again not considerably affected by gender or career experience; although, for male practitioners, the consistency value dropped to $\alpha_C = 0.85$. The values obtained for information quality were similar to the previous dimensions, with an average value of 5.74 ± 1.44 overall ($\alpha_C = 0.90$), with higher consistency for females ($\alpha_C = 0.96$) than males ($\alpha_C = 0.74$). Finally, with respect to interface quality, the overall mean rating was 5.81 ± 1.11, with the lowest internal consistency value overall ($\alpha_C = 0.77$) and considerable differences between demographic groups, with a higher $\alpha_C = 0.88$ for females than males ($\alpha_C = 0.34$). This is the only dimension where internal consistency dropped below an *acceptable* level, and it is probably due to the small number of PSSUQ items that it considers (i.e., only three).

4.3. Limitations

This study's findings should be interpreted within the context of certain limitations that warrant consideration and potential implications for future research. The sample might include participants who were already comfortable with technology or had positive attitudes toward it. Future research could aim for a broader and more diverse sample that includes individuals with varying degrees of technological familiarity or those who might be more resistant to technology adoption.

Due to the implemented pilot's logistics and the duration of the interactive sessions, perceptions were assessed after a brief interaction with the devices. Longer-term studies assessing sustained engagement and usability over time would provide a more comprehensive understanding of technology acceptance among senior adults. Along the same line, participants' initial positive perceptions might change with prolonged use or exposure to more complex tasks. Future studies could track participants' experiences over time to assess potential challenges or changes in perceptions as they become more familiar with the devices.

Future research could also further explore contextual factors, such as socio-economic status or cultural background, to provide a more nuanced understanding of perceptions across diverse groups, and could incorporate additional measures, such as cognitive performance, task completion rates, and qualitative feedback, to gain a more holistic view of technology acceptance and its impact on cognitive assessment.

5. Conclusions

The results obtained after interacting with both smart speakers and tablets were positive. These findings support the conclusion that both tools are perceived as suitable and user-friendly. Participants showed a favorable perception in terms of usefulness, ease of use, and enjoyment when using the two tools. This means that they are perceived as tools that provide them with benefits when compared to traditional approaches, and add value to their experiences. In addition, they rated their ease of use positively, indicating that they did not have significant difficulties interacting with them. This aspect is especially important when working with elderly people, as ease of use is related to satisfaction and perceived enjoyment, which are important to ensure a positive experience.

To address the limitations enumerated above in future research, we plan to design longitudinal studies to assess participants' experiences with these technologies over an extended period, employing a broader, more diverse, and representative sample to capture a wider range of attitudes and experiences toward technology. Additionally, both quantitative and qualitative measures should be incorporated to comprehensively evaluate perceptions, including cognitive performance metrics and in-depth interviews, considering the impact of contextual factors on technology acceptance among senior adults. A complementary line of work would involve exploring interventions or adaptations in the design of devices based on user feedback to improve usability and acceptance among older adults.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Research Ethics Committee of Galicia (protocol code 2023/15), approved on 21 March 2023.

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

Data Availability Statement: The raw data utilized in this study are available upon request to the corresponding author.

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Abbreviations

The following abbreviations are used in this manuscript:

CART	Classification and regression trees
CLTV	California Learning Verbal Test
GDS	Global Deterioration Scale
ICT	Information and communication technologies
MCI	Mild cognitive impairment
MoCa	Montreal's Cognitive Assessment test
OMT	Online mapping technology
PE	Perceived enjoyment
PEOU	Perceived ease of use
PSSUQ	Post-Study System Usability Questionnaire
PU	Perceived usefulness
SPSS	Statistical Package for the Social Sciences
TAM	Technology Acceptance Model
T-MoCa	Telephone version of MoCa

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