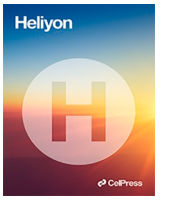
Heliyon 10 (2024) e25944

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon



Research article

Trust and attitude toward information presented using augmented reality and other technological means

Gilad Taub *, Avshalom Elmalech, Noa Aharony

Information Science Department, Bar-Ilan University, Ramat Gan, Israel

ARTICLE INFO

Keywords and Phrases:
Augmented reality
Trust
Digital information
Perceived trustworthiness
Presentation mode

ABSTRACT

In recent years, augmented reality (AR) technology has grown, and its use has become widespread among smartphone users. People are consuming more and more digital information from various sources and in different presentation modes. Therefore, in this study, we investigate the extent to which different presentation modes relate to the level of trust in information, while considering demographic variables, as well as personality traits and thinking styles. The participants in our experiments were asked to indicate whether certain statements that were presented in various presentation methods (image + text, image + audio, AR + text, AR + audio) were true or false. The results indicate that users are more likely to trust statements that are accompanied by AR than statements that are accompanied by a static image. In addition, younger participants have greater trust in audio-presented information than text-presented information. As AR is expected to grow considerably in popularity in the next few years, users should be cautious of the potential impact on their trust in digital information while using AR.

1. Introduction

Teachers, intellectuals, and business people agree that the phrase “knowledge is power” attributed to Sir Francis Bacon (1597) is no less relevant 400 years later. Knowledge is of great importance when we make an informed decision. For example, deciding where our next vacation will be, which power bar to purchase, etc., depends on our knowledge of those items. Our knowledge comes from many different information sources and in different forms. In the digital age, much of our information comes from digital information sources and through digital tools, such as smartphones. In fact, prior research indicates that a significant number of people rely on smartphones as their main source of information [1–3].

Since in the digital age we are exposed to information from various sources that are not controlled and may even contain incorrect or manipulative information, it is very important to be aware of the dangers involved in relying on this information as it affects our day-to-day decision-making. Trust in digital information is becoming increasingly critical due to the growing prevalence of the Internet and the increased reliance on digital information, for several reasons [4]. The Internet has resulted in an abundance of information, making it challenging to distinguish between accurate and credible sources and misinformation, disinformation, and fake news. In addition, digital information can be easily manipulated, altered, or even entirely fabricated. This allows hostile actors to disseminate false or misleading information for various purposes, including social manipulation. As the Internet’s prevalence continues to grow and shape various aspects of modern life, ensuring trust in digital information is essential.

* Corresponding author.
E-mail address: taubgil@biu.ac.il (G. Taub).

https://doi.org/10.1016/j.heliyon.2024.e25944
Received 18 May 2023; Received in revised form 31 January 2024; Accepted 5 February 2024
Available online 6 February 2024

Trust in digital information includes several factors, such as the credibility of sources, security and privacy of data and quality of the information [5]. There are challenges involved in building and managing digital trust. Challenges include understanding the factors that contribute to the formation of trust in digital information [4]. This research examined some of these factors. For example, individuals' distinct personality traits, as well as their distinct preferences and thinking styles, affect the way they process information [6].

By understanding the association between presentation modes and personality traits, it becomes possible to develop algorithms and systems that dynamically adapt content to individual preferences, making information consumption more efficient and enjoyable. In addition, understanding how presentation modes align with personality traits can help tailor communication strategies to better resonate with specific audiences. This can lead to more effective and engaging communication. Furthermore, people's decision-making processes are influenced by their personalities and thinking styles. Understanding these connections can aid in designing presentations that cater to the specific cognitive patterns of the target audience [7–9].

As technology advances, personalized content delivery becomes more feasible. Therefore, understanding the association between presentation modes and personality traits and thinking styles offers practical applications in communication, education, marketing, and various other fields. During the past few years, there has been a significant increase not only in the production of augmented reality (AR) technology, but also in its consumption, particularly among smartphone users. Since this technology has gained momentum in recent years, we expect that the amount of information that people will consume through this technology will also increase. When information is consumed through smartphones, it can be in the form of text, image, or audio. However, when information is consumed through AR technology, the information becomes more tangible, since it is integrated into users' reality [10,11].

These different forms of information consumption cause us to ponder whether users trust certain forms more than others. Previous research examining trust in digital information focused mostly on comparing text versus audio versus video. Findings show that high level of trust were found when information was presented via video or audio versus text or pictures [12–15]. These studies did not examine the perceived trustworthiness of information presented by AR or by images accompanied by text or audio. In addition, in past studies that examined the effect of information on decision makers, the effect was not examined when the information was acquired through the use of a smartphone [13–16]. According to these findings, it seems that richer communication modes generate greater trust among people.

Due to the current and expected growth of the use of AR technology in smartphone apps, it is crucial to examine its ramifications, including its potential inherent threats. Moreover, since AR technology conveys information to the user in a unique and multi-sensory manner, the information presented by AR may be perceived as more trustworthy by users than traditional information presented by image, audio, or text means. Our concern is to the likelihood that software developers and commercial companies may use this technology maliciously to manipulate users' opinions. Therefore, in our study, we chose to investigate if such a relationship exists, and present our users with information via text and audio, accompanied by AR or images, on smartphones.

Since there is a need for further understanding of which presentation modes generate a greater perception of information trustworthiness among users, the goal of this research is to examine whether there is a difference in participants' trust in information that is presented to them using different presentation modes via two senses (sight and hearing). Presentation modes include images and AR. In addition, the study examines the relationship between different personality traits and trustworthiness of information when it is presented in different ways.

The study addresses the following research questions:

RQ1. Which of the four presentation modes (image and text, image and audio, AR and text, AR and audio) is most associated with the perceived trustworthiness of presented statements?

RQ2. Is the association of the four presentation modes with the perceived trustworthiness of presented statements uniform across different demographic subgroups?

RQ3. Is the association of the four presentation modes with the perceived trustworthiness of presented statements uniform across different personality traits, specifically, openness to experience and liberal vs. conservative thinking styles?

The main finding of this study is that people trust information presented to them via text and audio accompanied by AR more than information presented by these forms accompanied by an image. This study should arouse worries about the possibility that some entities (commercial, governmental, hackers, etc.) may misuse this technology to manipulate information, (mis)leading individuals to believe that visual information displayed by AR (on a headset or on a mobile device) is trustworthy. An additional important finding is that participants of different ages trusted information presented via audio means differently.

In the following section, we describe the necessary background required for our study. We next present the research questions, the design, and the details of the experiments. We conclude by presenting the results and a discussion about the results.

2. Literature review

In this section, we review literature related to trust in digital information, comparing text with audio and with video. Then we follow with literature that examines AR and the trustworthiness of information presented with AR. Finally, we introduce several variables (such as openness to experience and thinking styles) that may predict how trustworthy digital information is when presented in various modes.

2.1. Information presentation and human behavior

Information is very important to our decision-making process and relates to our behavior. The way in which information is presented to people through digital media may have a correlation with their ensuing behavior, comprehension, engagement, and trust, as will be discussed below. Internet usage is playing a greater and greater role in the lives of many people. Therefore, trust in information is becoming increasingly critical. Researchers have raised the issue of whether users have become more gullible regarding information obtained from the Internet or, on the contrary, are reluctant and cautious when relating to such information [5,17]. Over the years studies have found correlations between trust in digital information and the usage of user interface (UI) and user experience (UX). Well-designed UI and UX significantly contribute to the development of the user's confidence and trust in the information presented in the digital domain [18–20]. Digital information may be presented in various formats. One of the latest studies found differences between the comprehension of college students while presented information via e-book (text format), audio book (audio format), and e-audio book (both text and audio formats). The last showed better comprehension compared to the other two groups [21]. An even more recent study compared the comprehension of adult participants while presented with four different formats of an audio lesson: audio-only, audio with subtitles, audio with video, and audio with both subtitles and video. That study found that subtitles facilitated comprehension, whereas video did not. Thus, we see that different forms of media presentation affect users' comprehension [22]. Prior research has suggested that trust of users in information is affected by the way it is presented to them. Website visitors are more inclined to believe a site and rate it and its promoted product more favorably if the site contains audio/video testimonials than if it includes either text or picture testimonials or none at all [12].

Past research [23,24] attempted to investigate which media formats impact participants' levels of engagement and recall, comparing video, text, and video-with-text formats with equivalent information. When presenting the three formats to a study group, it was found that both the video and video-with-text versions produced greater engagement than the text-only version, as well as improved recall of information. Participants reported that the video was more engaging than the text. In addition, AR has also been found to offer an engaging experience to students, making it an effective medium for teaching certain subjects and enhancing students' ability to learn and remember information [25].

2.2. Trust in digital information: text vs. audio vs. video

Online trust is defined by Corritore as: "the trust that occurs for an individual person towards a specific transactional or informational website" [26]. Several experiments have examined the trustworthiness of information presented to participants via human voice, video, or text chat. All found elevated levels of trust when communication was more human-based. For example, an experiment examining the trust of participants in a social dilemma game through four communication methods—face-to-face, video, audio, and text chat—found that video and face-to-face communication achieved the highest level of trust. Audio communication achieved an intermediate level of trust and text-based chat achieved the lowest level of trust [27,28]. Supporting these findings are further studies comparing trust among humans according to different presentation modes, where it was shown that audio was more trustworthy than text [13–16]. We see that richer communication modes seem to generate greater trust among people.

However, these results are inconclusive, as seen by research that examined how different types of online information affect the perception of reliability in the case of online dating, examining the impact of images (i.e., photographs) vs. text (i.e., "About me" section). In this case, trustworthiness was found to be higher when textual material was used. When a photograph was added, perceived trustworthiness was diminished [29]. Another research investigated which type of information on an e-commerce Facebook page generated the greatest level of trust among viewers. It concluded that detailed product information and interactivity contributed significantly to trust [30]. Further research has found that users' ability to discriminate was weakest for video-only, better for audio-only, and strongest for video + audio [31].

2.3. Trust in information presented by augmented reality

Augmented reality (AR) was defined by Azuma (1997) as "a variation of Virtual Environments (VE), or Virtual Reality as it is more commonly called. VE technologies completely immerse a user inside a synthetic environment. While immersed, the user cannot see the real world around him. In contrast, AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. Therefore, AR supplements reality, rather than completely replacing it" [32].

Today we refer to AR as a technology that enhances a person's view of the real world by superimposing digitally-added visual, audio, or other sensory information on top of it. The availability of commercial software development kits (SDKs) and the capabilities of display devices such as tablets, smartphones, and smart glasses have contributed to a recent surge in interest in the field of AR [33].

Research has found growing use of AR in many fields, such as education, advertising, health, and more [34]. AR has been enhanced in recent years and has become more cost-effective and widely available [35]. Grand View Research, Inc. states that the adoption of AR is experiencing rapid growth across multiple sectors, notably in education and retail, where trustworthiness is of paramount importance. Furthermore, the global demand for AR is expected to rise at a compound annual growth rate of 43.8% until 2028, when it is expected to be worth over 340 billion dollars. The industry is expected to be tremendously diverse and extremely large [36].

In recent years, AR has come about and is a modern and innovative presentation mode that has gained significant popularity. We are witnessing the use of AR in many fields, such as in medicine, education, gaming, tourism applications, museums, marketing and advertising, etc. [37]. Researchers suggested that the use of AR in commerce contributes to the trust of consumers [38]. Another study showed that AR applications have a more substantial impact on consumer trust and purchase intentions than traditional advertising

applications and more than real experiences [37]. Others indicated that trust in AR apps was a determinant of consumer intention to purchase from an online/offline store [39]. AR applications have high potential for use in automated driving, as well. Some of the fundamental obstacles that could prevent the adoption of automated driving stem from a lack of trust in technology. User trust and acceptance can be bolstered by the use of AR assistance to communicate system decisions [40]. AR has been found to outperform icon-based indicators in automated vehicles with a greater level of trust, a superior UX, and quicker, less error-prone takeovers [41]. In a review of five AR UI approaches, the authors came to the conclusion that providing users with an AR-based preview of route information considerably boosts their trust in automated vehicles [42]. From these studies it is apparent that the user interface can have an effect upon users' trust in the information presented.

As we see, there are many studies examining trust in information presented by AR, but there is a gap in the current literature regarding the impact of individuals' perceptions of the trustworthiness of information presented to them through different communication channels (image accompanied by text or audio vs. AR accompanied by text or audio). The objective of our study is to address this gap. Our study also investigates to what extent different thinking styles can be associated with the trustworthiness of different presentation methods.

Moreover, in our study we address two further variables: 1) Openness to experience, which is a personality trait, and 2) Liberal and conservative thinking styles of participants that may be associated with trustworthiness regarding presentation of information and to the best of our knowledge have not been investigated in the context of information presentation methods. Our study examines possible correlations between trustworthiness regarding different presentation modes and openness to experience and thinking styles. People with these traits tend to be more creative, unconventional, imaginative, curious, and willing to try new things [43]. Some of our presentation modes were conservative and others were more innovative. Thus, we wanted to explore whether certain presentation modes are associated with openness to experience, conservative or liberal thinking, and whether these are associated with trust in digital information.

Openness to experience is one of the traits that appear in the Big Five personality questionnaire [44].

(see Appendix, Table A.2). People with this trait tend to be more creative, unconventional, imaginative, and curious and also display flexible thinking [45]. People with high levels of openness are willing to try new things and to consider new and unconventional ideas [43,46,47]. People who are more open tend to trust computers and recent technologies more than those that score lower regarding this trait [48,49]. Research showed that openness to experience is significantly associated with willingness to accept the use of different forms of AR [50,51]. Similar to our research regarding trustworthiness in digital information, previous research examining trust while using social media and e-commerce has also made use of the openness section of the Big Five [52–54].

Thinking style theory proposes that individuals have unique patterns or ways of approaching problem-solving and decision-making [55]. In our study, we focus on the correlation between liberal and conservative thinking styles and the trustworthiness of different presentation methods (Liberal and Conservative sections, see Appendix, Table A.3). Individuals with liberal thinking exhibit a high tolerance to change and thrive when encountered with unfamiliar or new experiences. They enjoy seeking creative solutions and experiencing new techniques while resenting traditional and mundane routines [56]. Those who are considered more conservative prefer to adhere to familiar routines and prefer to avoid change. They are more reluctant to be creative and to try unfamiliar ways and solutions to existing tasks or problems they experience [56,57]. Thinking styles have also been associated with trust in digital information [58,59].

Thus, our study investigates to what extent different thinking styles can be associated with the trustworthiness of different presentation methods. Our study also builds upon and expands past studies that dealt with the relationship between different presentation modes and trust in information. In addition, our research studies that relationship when using a presentation mode that has not been examined before.

3. Method

3.1. Experiment design

3.1.1. Participants

Our research was based on a convenience sample. The main author of the article proactively reached out to people from diverse backgrounds and age groups within his social network, inviting them to participate in the experimental study.

The participants in this study were 100 Israeli adults, 50 males and 50 females, between the ages of 18 and 56 ($M = 34.54$, $SD = 12.20$). One third of them had no higher than a high school education, 39% had bachelor's degrees (B.A., B.Sc), and 28% had graduate degrees (M.A., M.Sc, PhD).

3.1.2. Tools

For this study, we developed an online AR mobile web app. The mobile app was built as a web app using HTML and JavaScript and was developed using the AR/VR 'A-Frame' framework (www.aframe.io). This framework enabled the presentation of an AR experience according to the designated setup. This framework also enabled us to provide the research participants with an identical user experience on both iOS and Android mobile devices. Hence, the participants' device hardware or operating system did not affect their experience nor their response. The app presented text, audio, and images and was able to use the mobile device camera to show the participant's environment, augmented with a superimposed virtual object (AR). The app's purpose was to examine participants' level of trust in information that was presented to them via different modes.

The following tools were employed in this study and are presented in the Appendix.

Evaluation of 12 facts as true/false. Twelve statements were presented according to the 2 × 2 design of the study (manner of statement presentation—text/audio; visual form—image/AR). The respondents were requested to indicate true or false for each statement, although all statements were actually false. The score for each dimension was the sum of "true" answers, ranging between 0 and 3.

Openness to experience was assessed using a questionnaire excerpted from the Big Five personality traits [44]. Ten items, such as "I see myself as someone who is curious about many different things," and "I see myself as someone who is original, comes up with new ideas," were rated on a 5-point scale from "strongly disagree" (1) to "strongly agree" (5). (see Appendix, Table A.2 for the questionnaire).

Internal consistency in the current study was acceptable: $\alpha = 0.74$. The total score was composed of the mean of the items, such that a higher score reflects greater openness to experience.

Thinking styles were assessed using the Thinking Styles Inventory-revised II [55]. Two thinking styles were used—five items for liberal thinking style, such as "I like to challenge old ideas or ways of doing things and to seek better ones," and "When faced with a

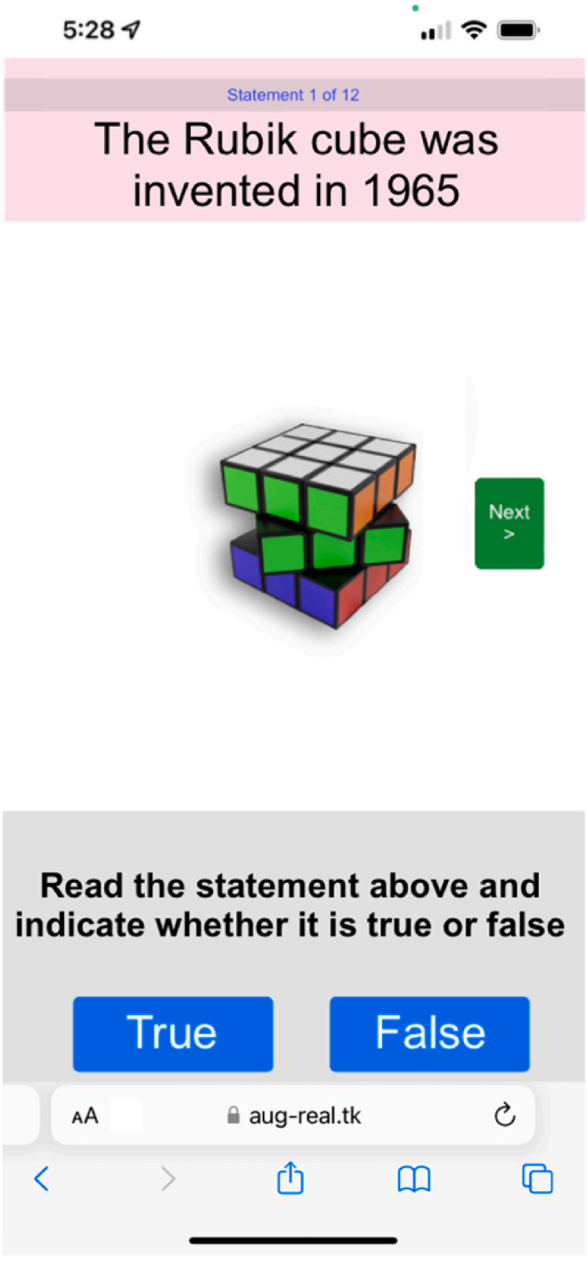


Fig. 1. Statement presented via image and text.

problem, I prefer to try new strategies or methods to solve it", and five items for conservative thinking style, such as "I like situations where I can follow a set routine," and "I stick to standard rules or ways of doing things." (see Appendix, Table A3 for the questionnaire).

Items were rated on a 7-point scale from "not at all so" (1) to "extremely so" (7). Acceptable internal consistencies were found in the current study: liberal thinking style $\alpha = 0.80$, conservative thinking style $\alpha = 0.68$. Total scores were composed of the mean of the items, such that higher scores reflect more liberal or more conservative thinking styles. The correlation between the two scales was $r = 0.40$ ($p < .001$).

Demographic information: gender, age, level of education.

3.1.3. Procedure

Participants were requested to use their mobile phones in order to participate. They received a text message including a link to begin the experiment. The text message included a short explanation and informed participants that they would stay anonymous and that no personal or private information would be collected during the experiment. By clicking the link they received, participants

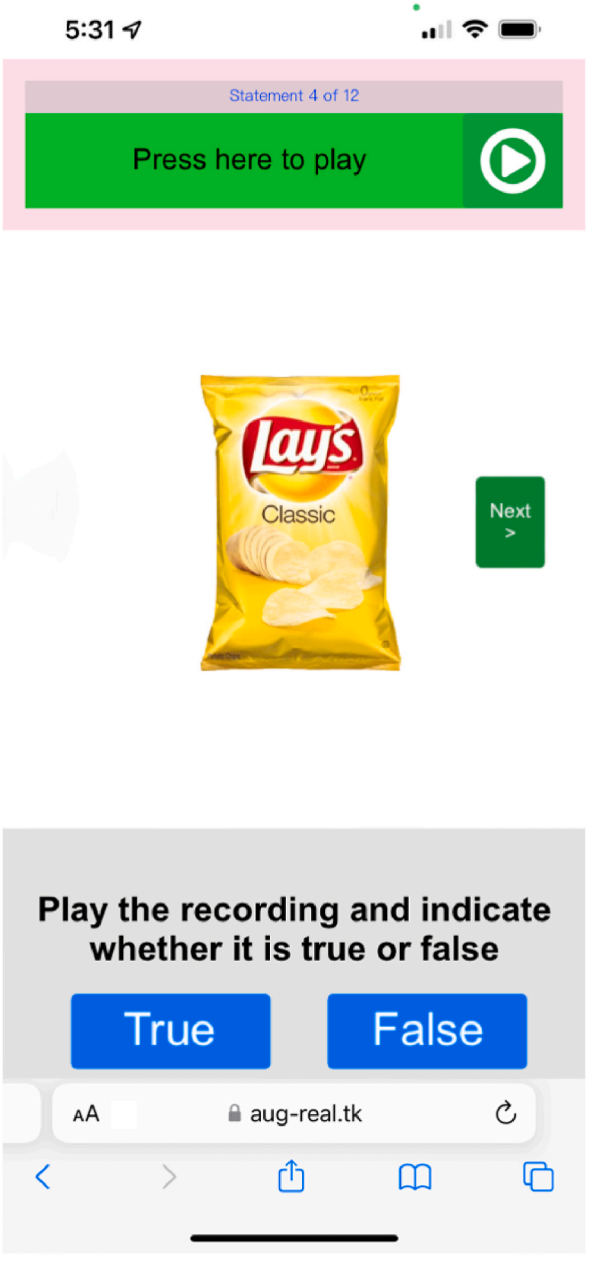


Fig. 2. Statement presented via image and audio.

expressed their consent to participate in the experiment. Participants were able to leave the experiment at any given point if they chose to. Participants received very detailed instructions about the experiment procedure and the steps they needed to follow.

The authors employed a unique code to ensure that each participant could participate only once in the experiment. After opening the link, participants were asked to answer a demographic survey, including several questions regarding gender, age, and level of education. Following that, they responded to 20 items derived from the Big Five questionnaire (Openness section) and the Steinberg thinking style questionnaire (Liberal and Conservative sections). After responding to these items, participants were presented with 12 different statements, such as "Coffee is the most sold product in the world," "Apple trees produce fruit year-round," "Potato chips were invented in England," and "The aloe vera plant can also be used to create paper." (All presented statements were false.) (See Appendix, Table A.1 for the full list of statements.)

In order to generate a final list of statements that are not based on participants' prior knowledge, we conducted a pilot study. In this pilot, we selected ten adults between the ages of 18 and 60, who were given a list of statements and asked to indicate whether the statements were true or false. These statements were compiled by the authors specifically for this research. All statements were clear and unequivocal. After reviewing the participants answers, we eliminated the statements that a large majority of the participants

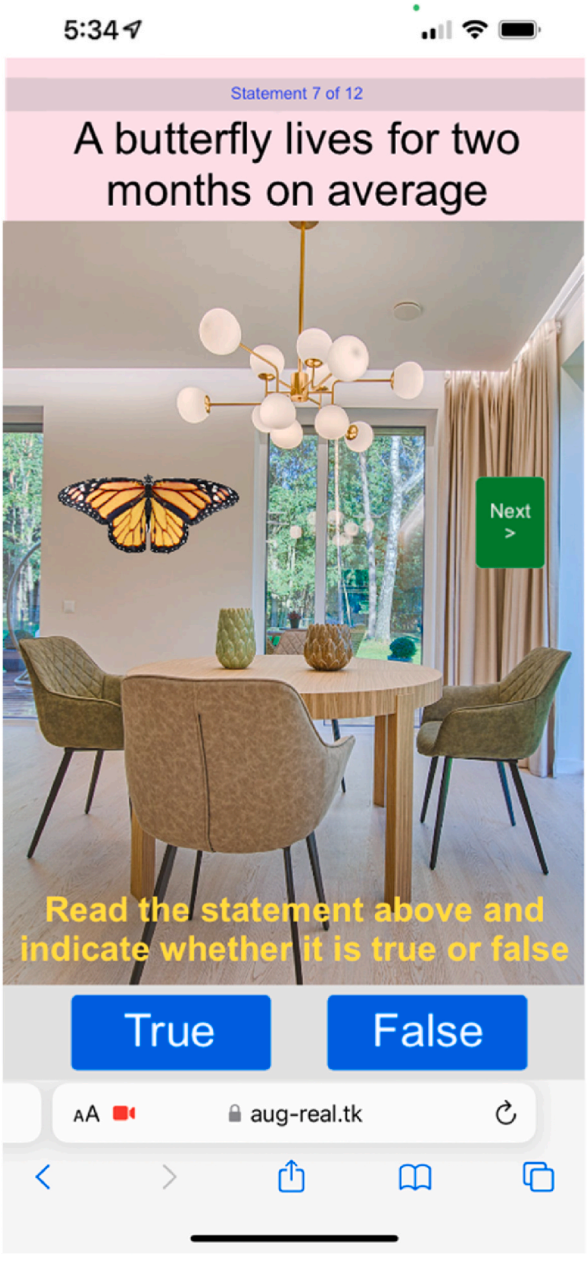


Fig. 3. Statement presented via AR display and text.

answered correctly or incorrectly. The 16 statements that were chosen for the main experiment were the ones that were answered correctly by approximately 50% of the participants. This indicated that the participants likely did not have prior knowledge of the subject matter related to these statements.

To increase the reliability of the experiment, the statements in the actual experiment were presented in random order. Each statement was presented using one of the four optional presentation modes, such that each participant saw a different combination of statements presented in different modes. For example, with the statement "The Rubik cube was invented in 1965," one participant saw an image of the Rubik cube on a white background, while another participant saw the same image as an AR object superimposed on the participant's environment.

In the AR app presented to participants, twelve statements were chosen arbitrarily. Participants were asked to indicate true or false for each statement presented. The 12 statements were divided into four different presentation modes. During the experiment, each participant was exposed to four different stimuli (presentation modes). These will be explained in further detail below. The first mode of presentation included an image that appeared together with relevant text on the screen describing the statement (see Fig. 1). The second mode included an image that appeared together with a play icon to enable participants to hear the relevant statement via an

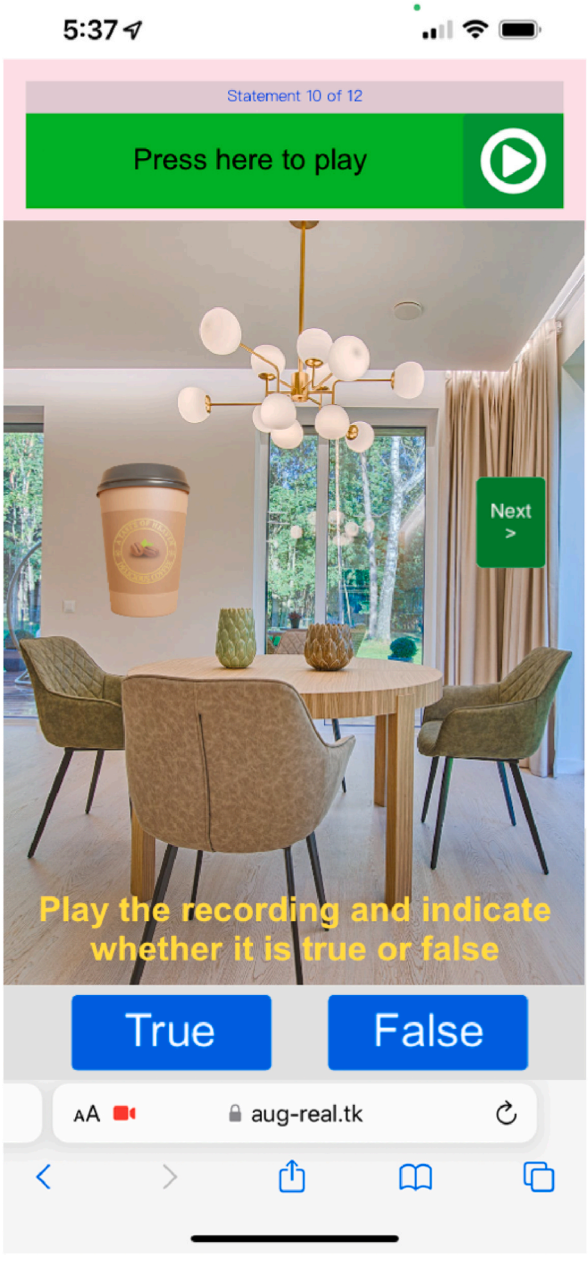


Fig. 4. Statement presented via AR display and audio.

audio recording (see Fig. 2).

(Note: 3D Images retrieved from https://www.cgtrader.com/free-3d-models).

The third mode included a 3D AR object that floated on the smartphone display, with relevant text describing the statement (see Fig. 3). The fourth mode included a 3D AR object that floated on the smartphone display and appeared together with a play icon to enable participants to hear the relevant statement via audio recording (see Fig. 4).

It is important to note that in Results (see section 5) we refer to the images and AR presentations as the **visual form**. The format of the information as it was presented to participants (text vs. audio) is referred to as the **statement presentation**.

(Illustration of mobile app screen. Picture of living room retrieved from https://www.pexels.com - Pixabay. 3D objects retrieved from https://www.cgtrader.com/free-3d-models).

Participants completed the experiment within 15 min on average.

The study was designed as a 2 × 2 within-subjects design of manner of statement presentation by visual form (manner of statement presentation—text/audio; visual form—image/AR).

3.2. Data analysis

Data were analyzed with SPSS ver. 28. Descriptive statistics used means and standard deviations and frequencies and percentages. Response difference by manner of statement presentation and visual form was calculated with a repeated-measures two-way analysis of variance, including the interaction. Response difference by manner of statement presentation, visual form, and a demographic or a personal variable, was calculated with a repeated-measures three-way analysis of variance, including all two-way and three-way interactions. Significant interactions were interpreted with estimated marginal means.

It should be noted that in all tables the means for the experimental conditions (text/audio by image/AR) represent the summary scores for the three items per each cell, and thus range between 0 and 3. The total scores (bottom row and right hand columns) are estimated marginal means, representing the means of these summary scores over the experimental conditions. They thus range between 0 and 3 as well, even though they represent 6 and 12 items.

Sample size was calculated using G*Power 3.1.9.7 [60]. For a repeated-measures analysis of variance with a demographic/personal covariate, a moderate-low effect size $f = 0.163$ (equals $\eta^2 = 0.026$), $\alpha = 0.05$, and power = 0.80, the required sample size is $N = 100$. In addition, using a moderate-low effect size $f = 0.205$ (equals $\eta^2 = 0.040$), $\alpha = 0.05$, and power = 0.95, the required sample size is $N = 100$. Results with lower effect sizes should be regarded with caution.

4. Results

4.1. "True" responses by manner of statement presentation and visual form

The results of the experiment that was aimed to examine participants' responses to various presentation modes accompanied by text/audio are presented in Table 1. The mean and standard deviations are shown for each presentation mode. Each of the four presentation modes (image/augmented reality by text/audio) included three true/false questions (see tools section), and its score was the sum of "true" answers, ranging 0–3.

As demonstrated in the table, responses to facts with images averaged at 1.47 (SE = 0.06), while responses to facts with augmented reality averaged at 1.62 (SE = 0.06). Further, responses to facts with text averaged at 1.54 (SE = 0.06), and responses to facts with audio averaged at 1.55 (SE = 0.06). A repeated-measures analysis of variance of the responses, by manner of statement presentation and visual form (2 × 2), and their interaction, was found significant for the visual form (image vs. AR) ($F(1, 99) = 4.38$, $p = .039$, $\eta^2 = 0.043$) and non-significant for the manner of statement presentation (text vs. audio) ($F(1, 99) = 0.01$, $p = .954$, $\eta^2 = 0.001$), or their interaction ($F(1, 99) = 0.03$, $p = .867$, $\eta^2 = 0.001$). That is, participants tended to consider as true statements presented with augmented reality more than they did regarding statements presented with images. No difference was found between text and audio.

4.2. "True" responses by manner of statement presentation, visual form, and demographic characteristics

The results of the experiment that was aimed to examine participants' response to various presentation modes accompanied by text/audio together with their demographic background are shown below. First, we present results related to gender, followed by results related to level of education, and finally results related to age.

Table 1
Means and standard deviations for "true" responses by experiment conditions (N = 100).

	Image *M* (*SD*)	Augmented reality *M* (*SD*)	Total *M* (*SE*)
Text	1.46 (0.85)	1.63 (0.86)	1.54 (0.06)
Audio	1.49 (0.93)	1.61 (0.91)	1.55 (0.06)
Total *M* (*SE*)	1.47 (0.06)	1.62 (0.06)	1.55 (0.06)

Note: Range for each mean score is the sum of "true" answers, i.e., 0–3. Total scores were derived from estimated marginal means.

4.2.1. Gender

A repeated-measures analysis of variance of the responses, by manner of statement presentation, visual form, and gender (2 × 2 × 2), was calculated. All gender-related differences were found non-significant: visual form by gender (F (1, 98) = 0.45, p = .504, η^2 = 0.005), manner of statement presentation by gender (F (1, 98) = 0.27, p = .606, η^2 = 0.003), visual form by manner of statement presentation by gender (F (1, 98) = 0.37, p = .544, η^2 = 0.004), and the main effect of gender: (F (1, 98) = 0.02, p = .876, η^2 = 0.001).

4.2.2. Level of education

Level of education was defined as academic (67%) vs. non-academic (33%).

Table 2 presents the mean and standard deviations for each presentation mode according to level of education. A repeated-measures analysis of variance of the responses, by manner of statement presentation, visual form, and level of education (2 × 2 × 2), was found significant for visual form by level of education (F (1, 98) = 5.16, p = .025, η^2 = 0.051). It was not significant for manner of statement presentation by level of education (F (1, 98) = 1.07, p = .304, η^2 = 0.011), the three-way interaction (F (1, 98) = 0.27, p = .603, η^2 = 0.003), or the main effect of level of education (F (1, 98) = 0.97, p = .326, η^2 = 0.010).

Analysis of the significant interaction, with estimated marginal means, has revealed that participants with a non-academic education had a mean of 1.67 (SE = 0.11) for augmented reality, compared with a mean of 1.30 (SE = 0.11) for image, a significant difference (F (1, 98) = 9.17, p = .003, η^2 = 0.086). Participants with an academic education had a mean of 1.60 (SE = 0.08) for augmented reality, and a mean of 1.56 (SE = 0.08) for image, representing a non-significant difference (F (1, 98) = 0.15, p = .699, η^2 = 0.002). That is, participants with a non-academic education have trusted the augmented reality more than they trusted the image, while no such difference was found for participants with an academic education.

4.2.3. Age

Age was used as a continuous variable in the analysis, and divided in the median (median age = 33 years) for presentation. The mean and standard deviation of each condition are presented in Table 3. A repeated-measures analysis of variance of the responses, by manner of statement presentation, visual form, and age, was found significant for manner of statement presentation by age (F (1, 98) = 5.74, p = .019, η^2 = 0.056). It was not significant for visual form by age (F (1, 98) = 0.77, p = .383, η^2 = 0.008), the three-way interaction (F (1, 98) = 1.02, p = .316, η^2 = 0.010), or the main effect of age (F (1, 98) = 1.45, p = .231, η^2 = 0.015).

Analysis of the significant interaction, with estimated marginal means, has revealed that younger participants had a mean of 1.71 (SE = 0.09) for audio, compared with a mean of 1.51 (SE = 0.09) for text, a significant difference (F (1, 98) = 4.14, p = .045, η^2 = 0.041). Older participants had a mean of 1.40 (SE = 0.09) for audio, and a mean of 1.58 (SE = 0.09) for text, representing a non-significant difference (F (1, 98) = 2.29, p = .133, η^2 = 0.023). That is, younger participants have trusted the audio message more than they trusted the text, while no such difference was found for older participants.

4.3. "True" responses by manner of statement presentation, visual form, and personal characteristics

4.3.1. Openness to experience

The results of the experiment that aimed to examine participants' responses to various presentation modes accompanied by text/audio in relation to their personal characteristics, specifically openness to experience, are given here. Openness to experience was used as a continuous variable in the analysis, and divided in the median (median = 3.30) for presentation purposes. The mean and standard deviation of each condition are presented in Table 4. A repeated-measures analysis of variance of the responses, by manner of statement presentation, visual form, and openness to experience, was found significant for manner of statement presentation by openness to experience (F (1, 98) = 8.05, p = .006, η^2 = 0.076). It was not significant for visual form by openness to experience (F (1, 98) = 0.16, p = .691, η^2 = 0.002), the three-way interaction (F (1, 98) = 0.98, p = .324, η^2 = 0.010), or the main effect of openness to experience (F (1, 98) = 0.28, p = .597, η^2 = 0.003).

Analysis of the significant interaction, with estimated marginal means, reveals that participants with lower values of openness to experience had a mean of 1.41 (SE = 0.09) for text, compared with a mean of 1.65 (SE = 0.09) for audio, a significant difference (F (1, 98) = 4.95, p = .028, η^2 = 0.049). Participants with higher values of openness to experience had a mean of 1.66 (SE = 0.09) for text, and a mean of 1.46 (SE = 0.09) for audio, representing a non-significant difference (F (1, 98) = 3.03, p = .085, η^2 = 0.030). That is, participants with lower values of openness to experience have trusted the audio message more than they trusted the text, while no such difference was found for participants with higher values of openness to experience.

Table 2
Means and standard deviations for "true" responses by experiment conditions and level of education (N = 100).

	Image *M* (*SD*)		Augmented reality *M* (*SD*)		Total *M* (*SE*)	
	Non-academic	Academic	Non-academic	Academic	Non-academic	Academic
Text	1.18 (0.81)	1.60 (0.84)	1.67 (0.89)	1.61 (0.85)	1.42 (0.11)	1.60 (0.08)
Audio	1.42 (0.94)	1.52 (0.93)	1.67 (0.89)	1.58 (0.92)	1.54 (0.11)	1.55 (0.08)
Total *M* (*SE*)	1.30 (0.11)	1.56 (0.08)	1.67 (0.11)	1.60 (0.08)	1.48 (0.08)	1.58 (0.06)

Note: Total scores were derived from estimated marginal means.

Table 3
Means and standard deviations for "true" responses by experiment conditions and age ($N = 100$).

	Image *M* (*SD*)		Augmented reality *M* (*SD*)		Total *M* (*SE*)	
	Younger	Older	Younger	Older	Younger	Older
Text	1.48 (0.82)	1.44 (0.87)	1.54 (0.85)	1.71 (0.87)	1.51 (0.09)	1.58 (0.09)
Audio	1.67 (0.95)	1.33 (0.88)	1.75 (0.86)	1.48 (0.94)	1.71 (0.09)	1.40 (0.09)
Total *M* (*SE*)	1.57 (0.09)	1.38 (0.09)	1.65 (0.09)	1.60 (0.09)	1.61 (0.07)	1.49 (0.07)

Note: Total scores were derived from estimated marginal means.

Table 4
Means and standard deviations for "true" responses by experiment conditions and openness to experience (N = 100).

	Image *M* (*SD*)		Augmented reality *M* (*SD*)		Total *M* (*SE*)	
	Lower openness	Higher openness	Lower openness	Higher openness	Lower openness	Higher openness
Text	1.36 (0.92)	1.55 (0.77)	1.47 (0.83)	1.77 (0.87)	1.41 (0.09)	1.66 (0.09)
Audio	1.60 (0.85)	1.40 (0.99)	1.70 (0.91)	1.53 (0.91)	1.65 (0.09)	1.46 (0.09)
Total *M* (*SE*)	1.48 (0.09)	1.47 (0.09)	1.58 (0.09)	1.65 (0.08)	1.53 (0.07)	1.56 (0.07)

Note: Total scores were derived from estimated marginal means.

4.3.2. Liberal thinking style

Liberal thinking style was used as a continuous variable in the analysis. A repeated-measures analysis of variance of the responses, by manner of statement presentation, visual form, and liberal thinking style, was found non-significant: manner of statement presentation by liberal thinking style (F (1, 98) = 0.22, $p = .640$, $\eta^2 = 0.002$), visual form by liberal thinking style (F (1, 98) = 0.01, $p = .909$, $\eta^2 = 0.001$), the three-way interaction (F (1, 98) = 0.01, $p = .951$, $\eta^2 = 0.001$), the main effect of liberal thinking style (F (1, 98) = 1.84, $p = .178$, $\eta^2 = 0.018$)].

4.3.3. Conservative thinking style

Conservative thinking style was used as a continuous variable in the analysis. A repeated-measures analysis of variance of the responses, by manner of statement presentation, visual form, and conservative thinking style, was found non-significant: manner of statement presentation by conservative thinking style (F (1, 98) = 1.72, $p = .193$, $\eta^2 = 0.017$), visual form by conservative thinking style (F (1, 98) = 0.97, $p = .326$, $\eta^2 = 0.010$), the three-way interaction (F (1, 98) = 2.47, $p = .119$, $\eta^2 = 0.025$), the main effect of conservative thinking style (F (1, 98) = 0.82, $p = .369$, $\eta^2 = 0.008$).

5. Discussion

The main aim of this study was to examine whether presentation modes and the accompanying media are associated with participants' level of trust, while considering their demographic backgrounds, personality traits, and thinking styles. For the purpose of the research, we designed and developed a web-based AR mobile app that provided a realistic and interactive environment for participants to engage with the information. The study employed validated questionnaires to assess participants' personality traits and thinking styles, adding rigor to this research, and ensuring the measurement of these variables was reliable and valid, enhancing the overall quality of our research.

In our study, we aimed to investigate the effects of different presentation modes on participants' trust in digital information. To achieve this, we employed statistical analyses, specifically repeated-measures analysis of variance, to comprehensively analyze the collected data. Within-subject design allowed us to assess the impact of various presentation modes on participants' responses, while also taking into consideration potential individual differences by comparing the same participants' responses across different demographic backgrounds, as well as to personality traits and thinking styles. This analysis enabled us to determine whether these different modes of presentation had a significant effect on participants' trust. This specific method (use of within-subject design), enhanced the reliability and validity of our findings, allowing for a more accurate understanding of the impact of presentation modes on participants' trust.

Our first research question investigated which of the presentation modes is most associated with perceived trustworthiness. Findings revealed no association between the mode in which the questions were presented, whether text or audio, and participant's level of trust. However, a crucial finding of our study revealed significant differences between participants' trust in information presented via AR-accompanied text/audio in comparison to information presented via static images accompanied by text/audio. Our results aligned with the results reported in previous research that found that information presented in an interactive manner shows a positive and significant effect on trust and learning [30,61].

It is important to note that all the statements that were presented to our participants were false and even though this was the case, when this information was presented via AR, the participants showed higher levels of trust. We can assume this happens because AR is interactive, innovative, exciting, and different from the way users usually experience information presentation, especially in

comparison to information presented in a static visual manner, such as the images we presented to our participants. In research that compared trust levels among participants using five different presentation modes, it was suggested that video was the most trustworthy mode (AR was not examined in this research), and participants tended to choose richer media presentations [14]. In our research, the richest presentation form was AR and therefore we can assume that this was the reason that participants found it to be the most trustworthy. In line with this assumption, previous research has demonstrated that the use of AR contributes to consumers' trust and intention to purchase [37,38].

Our second research question examined the association between demographic background variables (age, gender, educational background) and the perceived trustworthiness of the statements, according to different presentation modes. In our study, we discovered significant correlations between age and text/audio presentation modes. The younger the participants, the greater their trust in audio-presented information over text-presented information.

Our results can be associated to some extent with previous studies that compared trust levels among participants while they were presented with information in alternate formats. One study compared between text-only, video, audio, avatar, or photo with text [14], and the second between text, audio, and video [13]. Findings in both studies presented higher levels of trust for audio presentation compared to text. While the aforementioned studies reported that audio is more trusted than text, our research also examined the association between demographic factors and the trust that participants have in each of the various presentation modes. The current findings reveal that younger participants perceive information presented to them via audio form to be more trustworthy than older participants. Although we have not found evidence for this phenomenon in previous studies, recent research showed that younger people (aged 18–29) trusted radio and radio news more than older people [59]. One explanation may be that younger participants tend to make more extensive use of audio messages when communicating via chat apps such as WhatsApp, and therefore they found audio to be more trustworthy than other presentation modes. Another possible explanation stems from the assumption that younger people tend to learn and gain knowledge via podcasts and other forms of audio presentations, in comparison to older participants, who hold on to a more traditional learning format based on written text.

Educational background was significantly associated with presentation modes of images and AR. Participants without academic background found the AR mode to be more trustworthy than images. On the contrary, no significant correlations were found for participants with academic backgrounds. A possible explanation for this difference is based on the assumption that the higher one's educational level, the more one tends to critically weigh information and the less enriched media information, such as AR, is associated with decisions. Perhaps those without higher education tend to be more likely to perceive AR as a trustworthy mode of information, since it is considered to be innovative and an up-to-date technology. Regarding gender, no significant difference was found between men and women and trust according to presentation modes.

Our third research question examined associations between trust in different presentation modes and personality traits, including openness to experience [44], and liberal or conservative thinking styles [55]. No associations were found between a higher level of openness and these presentation modes, similar to previous findings [52]. Further, no significant correlations were found between presentation modes and liberal or conservative thinking styles. It seems that trust in digital information is not associated with the openness to experience personality trait, nor with thinking styles. Nevertheless, the main takeaway from these findings is that the way information is presented to users has no significant association with the unique personality traits and thinking styles examined in this study.

Surprisingly, significant correlations were found between openness and text/audio presentation modes. A lower level of openness was correlated with more trust in the audio mode presentation, in comparison to text. Although this finding is interesting, further exploration is needed to better understand this behavior.

This study found that the use of AR in information presentation significantly increases participants' trust compared to static images. The study has several potential implications for the fields of Human-Computer Interaction (HCI), media design, and digital learning. Regarding HCI, incorporating AR into HCI interfaces could enhance trust in the information being presented. Designers and developers should explore the use of AR to create interactive and innovative experiences that promote trust and engagement.

There is great potential for AR in media design, where interactive and immersive experiences can be created to enhance trust and engagement with the content. Media designers can leverage AR technology to create compelling and trustworthy media experiences. Regading digital learning, the findings revealed that younger participants had a greater trust in audio-presented information compared to text-presented information. This suggests that digital learning platforms can incorporate audio-based content to enhance trust among younger learners.

6. Limitations and future work

Our study included a sample of 100 participants representing a subset of the population who volunteered their time without payment or secondary gain. One limitation of this study is the small sample size. This sample may not be representative of the larger population and may limit the generalizability of the findings. In addition, all participants were recruited within an advanced western democracy, whose norms emphasize individualism, autonomy, and self-expression more than many non-Western cultures [62–64] and tend to value traits such as originality, independence, and consistency [65,66]. Therefore, our findings should be treated with caution and cannot be generalized, since it is uncertain whether our conclusions are applicable to additional cultures.

Furthermore, our study does not assess whether participants remembered the misleading information presented to them during the experiment, which could affect the "long-term effect" validity of the results. The lack of memory check raises concerns about the robustness of the findings and the possibility of participants not being affected after the experiment by the misinformation presented to them during the experiment. This study examined participants' responses regarding unsolicited information presented to them.

Participants' behavior might be different when dealing with information that they actively search for. Another point is that the source of information can be a factor in participants' trust. In our study participants did not know the source of the information that was presented.

Another limitation is that the study relied only on a single method of data collection, which could be subject to bias or other sources of error. Furthermore, the study did not measure any control variables that could potentially affect the results of the study, such as participants' prior knowledge or experience in the area of study. Although the participants were unaware of the context of this study, which could be considered as a limitation, we viewed it as an advantage, since the participants were not influenced by this knowledge.

Future research may include usage of an AR headset instead of an AR mobile app to examine trust among users. In addition, it would be interesting to investigate the effect of diverse cultures regarding trust in relation to thinking styles and personality traits.

7. Conclusions

The main findings of our research stress that different forms of presentation modes are related to various levels of trust in digital information. Our research has found that information presented via AR accompanied by text/audio is perceived as more trustworthy than when presented as static images accompanied by text/audio. Further, we found that younger participants perceive information presented to them in audio form to be more trustworthy than older participants. Similar to previous findings, no associations were found between a higher level of openness and these presentation modes, nor between liberal or conservative thinking styles and presentation modes. Nonetheless, it may still be valuable to conduct further research on how individual characteristics influence trust perception. This could provide additional insights on how to tailor information presentation to various user profiles.

The findings of our research have significant implications for various applications, such as mobile app design, information conveyance, and media design. For example, mobile app designers should consider incorporating AR as an information presentation mode to enhance the perceived trustworthiness of the information presented to users. By doing so, users are more likely to trust the information provided through the app. Moreover, these findings emphasize the importance of using AR and audio-based presentation modes when conveying critical information or news. News outlets and media designers can leverage these presentation modes to enhance the credibility and trustworthiness of their content, especially among younger audiences. As AR is projected to become more prevalent in the coming years, users should be aware of the potential biases and manipulations that could occur. In light of our findings and the fact that the prevalence of AR is anticipated to increase significantly over the next few years, users should be wary regarding their trust in digital information when presented using AR. This research serves as a reminder for users to critically evaluate and verify the trustworthiness of digital information displayed through AR.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethics declarations

This study was reviewed and approved by the IRB of Bar-Ilan University.
The IRB provides ethics approval without an approval number.
All participants provided informed consent to participate in the study.

Data availability statement

Data used for the current study may be made available on reasonable request.

CRediT authorship contribution statement

Gilad Taub: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Avshalom Elmalech:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Noa Aharony:** Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

Table A.1
List of statements that were used in the experiment. All statements presented to participants were false. The correct information is shown in parentheses.

#	Statements
1	The Rubik cube was invented in 1965. (1974)
2	A butterfly lives for two months on average. (2–3 weeks)
3	The biggest selling batteries in the world are alkaline. (Lithium-ion)
4	The first laptop computer was manufactured in 1975. (1980)
5	The average piano has 77 keys. (88)
6	The terebinth tree is the only tree that does not emit oxygen. (It does emit, as all trees)
7	Potato chips were invented in England. (USA)
8	The word sofa originates from Italian. (Arabic)
9	One cup of Coke has the same number of calories as one cup of red wine. (Red wine has twice as many)
10	In 1965, "Tnuva" (milk manufacturer) started using bottles instead of jugs. (1955)
11	The first artificial flowers were invented in Persia. (Egypt and Rome)
12	The aloe vera plant can also be used to create paper. (Not true)
13	Coffee is the most sold product in the world. (Crude oil/gasoline)
14	The tulip is the unofficial symbol of France. (Holland)
15	The Turkish were the first to manufacture china dishes. (Chinese)
16	Apple trees produce fruit year-round. (Only during their season)

Table A.2
List of the Big Five, openness to experience items that were used in the experiment.
I see Myself as Someone Who.

#	Statements
5	Is original, comes up with new ideas
10	Is curious about many different things
15	Is ingenious, a deep thinker
20	Has an active imagination
25	Is inventive
30	Values artistic, aesthetic experiences
35R	Prefers work that is routine
40	Likes to reflect, play with ideas
41R	Has few artistic interests
44	Is sophisticated in art, music, or literature

Table A.3
List of Sternberg's thinking style items that were used in the experiment.

#	Liberal statements
Q45	I like to challenge old ideas or ways of doing things and to seek better ones
Q53	When faced with a problem, I prefer to try new strategies or methods to solve it
Q58	I like to do things in new ways not used by others in the past
Q64	I like to change routines in order to improve the way tasks are done
Q65	I like to take old problems and find new methods to solve them
#	Conservative statements
Q13	I stick to standard rules or ways of doing things
Q22	When I'm in charge of something, I like to follow methods and ideas used in the past
Q26	I like situations where I can follow a set routine
Q28	I like tasks and problems that have fixed rules to follow in order to complete them
Q36	When faced with a problem, I like to solve it in a traditional way

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e25944.

References

[1] D. Kim, K. Park, D.-J. Lee, Y. Ahn, Predicting mobile trading system discontinuance: the role of attention, Electron, Commer. Res. Appl. 44 (2020) 101008, https://doi.org/10.1016/j.elerap.2020.101008.

[2] X. Chen, Y. Wang, D. Tao, L. Jiang, S. Li, Antecedents of smartphone multitasking: roles of demographics, personalities and motivations, Internet Res. 31 (2021) 1405–1443, https://doi.org/10.1108/INTR-09-2019-0388.

[3] M.K. Qabalin, M. Naser, M. Alkasassbeh, Android spyware detection using machine learning: a novel dataset, Sensors 22 (2022), https://doi.org/10.3390/s22155765.

[4] R. D'Hauwers, J. van der Bank, M. Montakhabi, Trust, transparency and security in the sharing economy: what is the government's role? Technol. Innov. Manag. Rev. 10 (2020) 5–17, https://doi.org/10.22215/timreview/1352.

[5] K. Kelton, K.R. Fleischmann, W.A. Wallace, Trust in digital information, J. Am. Soc. Inf. Sci. Technol. 59 (2008) 363–374, https://doi.org/10.1002/asi.20722.

[6] P.R. Harris, E. Sillence, P. Briggs, Perceived threat and corroboration: key factors that improve a predictive model of trust in internet-based health information and advice, J Med Internet Res 13 (2011) e51, https://doi.org/10.2196/jmir.1821.

[7] N. Erceg, Z. Galić, Incremental Validity of Decision-Making Styles in Predicting Real-Life and Work-Related Outcomes, J. Individ. Differ. 45 (2024) 32-45, doi.org/10.1027/1614-0001/a000404.

[8] Y. Paik, J.M. Lee, Y.S. Pak, Convergence in international business ethics? A comparative study of ethical philosophies, thinking style, and ethical decision-making between us and Korean managers, J. Bus. Ethics. 156 (2019) 839–855, https://doi.org/10.1007/s10551-017-3629-9.

[9] M. Rzeszutek, A. Szyszka, M. Czerwonka, Investors' expertise, personality traits and susceptibility to behavioral biases in the decision making process, Contemp. Econ. 9 (2015) 237–352, https://doi.org/10.5709/ce.1897-9254.173.

[10] T.H. Kim, H.J. Choo, Augmented reality as a product presentation tool: focusing on the role of product information and presence in AR, Fash. Text. 8 (2021) 29, https://doi.org/10.1186/s40691-021-00261-w.

[11] J.G. Lee, J. Seo, A. Abbas, M. Choi, End-users' augmented reality utilization for architectural design review, Appl. Sci. 10 (2020), https://doi.org/10.3390/app10155363.

[12] O. Appiah, Rich media, poor media: the impact of audio/video vs. text/picture testimonial ads on browsers'evaluations of commercial web sites and online products, J. Curr. Issues Res. Advert. 28 (2006) 73–86, https://doi.org/10.1080/10641734.2006.10505192.

[13] Z. Babutsidze, N. Hanaki, A. Zylbersztejn, Nonverbal content and trust: an experiment on digital communication, Econ. Inq. 59 (2021) 1517–1532, https://doi.org/10.1111/ecin.12998.

[14] J. Riegelsberger, M.A. Sasse, J.D. McCarthy, Do people trust their eyes more than ears? Media bias in detecting cues of expertise, in: CHI 05 Ext. Abstr. Hum. Factors Comput. Syst., Association for Computing Machinery, New York, NY, USA, 2005, pp. 1745–1748, https://doi.org/10.1145/1056808.1057012.

[15] J. Riegelsberger, M.A. Sasse, J.D. McCarthy, Rich media, poor judgement? A study of media effects on users' trust in expertise, in: T. McEwan, J. Gulliksen, D. Benyon (Eds.), People Comput. XIX — Bigger Pict., Springer London, London, 2006, pp. 267–284, https://doi.org/10.1007/1-84628-249-7_17.

[16] D. Williams, S. Caplan, L. Xiong, Can you hear me now? The impact of voice in an online gaming community, Hum. Commun. Res. 33 (2007) 427–449, https://doi.org/10.1111/j.1468-2958.2007.00306.x.

[17] J.W. Fritch, R.L. Cromwell, Evaluating Internet resources: identity, affiliation, and cognitive authority in a networked world, J. Am. Soc. Inf. Sci. Technol. 52 (2001) 499–507, https://doi.org/10.1002/asi.1081.

[18] A. Al Sokkar, E. Law, Validating an episodic UX model on online shopping decision making: a survey study with B2C e-commerce, in: Proc. 5th ACM SIGCHI Symp. Eng. Interact. Comput. Syst., Association for Computing Machinery, New York, NY, USA, 2013, pp. 297–306, https://doi.org/10.1145/2494603.2480301.

[19] H. Albayati, S.K. Kim, J.J. Rho, A study on the use of cryptocurrency wallets from a user experience perspective, Hum. Behav. Emerg. Technol. 3 (2021) 720–738, https://doi.org/10.1002/hbe2.313.

[20] M.N. Amir Dirin, T.H. Laine, Feelings of being for mobile user experience design, Int. J. Human–Computer Interact. 39 (2023) 4059–4079, https://doi.org/10.1080/10447318.2022.2108964.

[21] Na-Young Kim, E-book, audio-book, or e-audio-book: the effects of multiple modalities on EFL comprehension, Engl. Teach. 76 (2021) 33–52, https://doi.org/10.15858/engtea.76.4.202112.33, 33.

[22] Y. Zheng, X. Ye, J.H. Hsiao, Does adding video and subtitles to an audio lesson facilitate its comprehension? Learn. Instr. 77 (2022) 101542 https://doi.org/10.1016/j.learninstruc.2021.101542.

[23] K.J. Kim, S.S. Sundar, Mobile persuasion: can screen size and presentation mode make a difference to trust? Hum. Commun. Res. 42 (2016) 45–70, https://doi.org/10.1111/hcre.12064.

[24] A. Yadav, M.M. Phillips, M.A. Lundeberg, M.J. Koehler, K. Hilden, K.H. Dirkin, If a picture is worth a thousand words is video worth a million? Differences in affective and cognitive processing of video and text cases, J. Comput. High. Educ. 23 (2011) 15–37, https://doi.org/10.1007/s12528-011-9042-y.

[25] R.A. Liono, N. Amanda, A. Pratiwi, A.A.S. Gunawan, A systematic literature review: learning with visual by the help of augmented reality helps students learn better, Procedia Comput. Sci. 179 (2021) 144–152, https://doi.org/10.1016/j.procs.2020.12.019.

[26] C.L. Corritore, B. Kracher, S. Wiedenbeck, On-line trust: concepts, evolving themes, a model, Int. J. Hum.-Comput. Stud. 58 (2003) 737–758, https://doi.org/10.1016/S1071-5819(03)00041-7.

[27] N. Bos, D. Gergle, J.S. Olson, G.M. Olson, Being there versus seeing there: trust via video, in: CHI 01 Ext. Abstr. Hum. Factors Comput. Syst., Association for Computing Machinery, Seattle, Washington, 2001, pp. 291–292, https://doi.org/10.1145/634067.634240.

[28] N. Bos, J. Olson, D. Gergle, G. Olson, Z. Wright, Effects of four computer-mediated communications channels on trust development, in: Proc. SIGCHI Conf. Hum. Factors Comput. Syst., Association for Computing Machinery, New York, NY, USA, 2002, pp. 135–140, https://doi.org/10.1145/503376.503401.

[29] C.L. Toma, Perceptions of trustworthiness online: the role of visual and textual information, in: Proc. 2010 ACM Conf. Comput. Support. Coop. Work, Association for Computing Machinery, New York, NY, USA, 2010, pp. 13–22, https://doi.org/10.1145/1718918.1718923.

[30] H. Sari, F. Mutaqin, A.P. Setiaboedi, The effect of different type of information on trust in Facebook page, in: 2018 Thirteen, Int. Conf. Digit. Inf. Manag. ICDIM (2018) 191–195, https://doi.org/10.1109/ICDIM.2018.8846978.

[31] M. Swerts, E. Krahmer, P. Barkhuysen, L. van de Laar, Audiovisual cues to uncertainty, in: ISCA Tutor. Res. Workshop Error Handl. Spok. Dialogue, Syst., 2003.

[32] R.T. Azuma, A survey of augmented reality, Presence Teleoperators Virtual, Environ 6 (1997) 355–385, https://doi.org/10.1162/pres.1997.6.4.355.

[33] P. Mendigochea, WebAR: creating augmented reality experiences on smart glasses and mobile device browsers, in: ACM SIGGRAPH 2017 Studio, Association for Computing Machinery, Los Angeles, California, 2017, pp. 1–2, https://doi.org/10.1145/3084863.3107580.

[34] İ. Sünger, S. Çankaya, Augmented reality: historical development and area of usage, J. Educ. Technol. Online Learn. 2 (2019) 118–133, https://doi.org/10.31681/jetol.615499.

[35] X. Qiao, P. Ren, S. Dustdar, L. Liu, H. Ma, J. Chen, A.R. Web, A promising future for mobile augmented reality—state of the art, challenges, and insights, Proc. IEEE. 107 (2019) 651–666, https://doi.org/10.1109/JPROC.2019.2895105.

[36] Augmented Reality Market Size, Share & Trends Analysis Report, 2021. https://www.grandviewresearch.com/industry-analysis/augmented-reality-market.

[37] B. Bilgili, E. Özkul, E. Koç, M.O. Ademoğlu, An investigation of augmented reality applications from the perspectives of brand trust and purchase intentions of customers, in: S. Grima, E. Özen, H. Boz, J. Spiteri, E. Thalassinos (Eds.), Contemp. Issues Behav. Finance, Emerald Publishing Limited, 2019, pp. 53–64, https://doi.org/10.1108/S1569-375920190000101005.

[38] P. van Esch, D. Arli, M.H. Gheshlaghi, V. Andonopoulos, T. von der Heidt, G. Northey, Anthropomorphism and augmented reality in the retail environment, J. Retail. Consum. Serv. 49 (2019) 35–42, https://doi.org/10.1016/j.jretconser.2019.03.002.

[39] J.-Y.M. Kang, J.-E. Kim, J.Y. Lee, S.H. Lin, How mobile augmented reality digitally transforms the retail sector: examining trust in augmented reality apps and online/offline store patronage intention, J. Fash. Mark. Manag. Int. J. (2022), https://doi.org/10.1108/JFMM-12-2020-0273 ahead-of-print.

[40] P. Wintersberger, A.-K. Frison, A. Riener, T. von Sawitzky, Fostering user acceptance and trust in fully automated vehicles: evaluating the potential of augmented reality, Presence Teleoperators Virtual Environ. 27 (2018) 46–62, https://doi.org/10.1162/pres_a_00320.

[41] H. Detjen, M. Salini, J. Kronenberger, S. Geisler, S. Schneegass, Towards transparent behavior of automated vehicles: design and evaluation of HUD concepts to support system predictability through motion intent communication, in: Proc. 23rd Int. Conf. Mob. Hum.-Comput. Interact., Association for Computing Machinery, New York, NY, USA, 2021, https://doi.org/10.1145/3447526.3472041.

[42] T. von Sawitzky, P. Wintersberger, A. Riener, J.L. Gabbard, Increasing trust in fully automated driving: route indication on an augmented reality head-up display, in: Proc. 8th ACM Int. Symp. Pervasive Disp., Association for Computing Machinery, New York, NY, USA, 2019, https://doi.org/10.1145/3321335.3324947.
[43] R.R. McCrae, P.T. Costa Jr., Empirical and theoretical status of the five-factor model of personality traits, in: SAGE Handb. Personal. Theory Assess. Vol 1 Personal. Theor. Models, Sage Publications, Inc, Thousand Oaks, CA, US, 2008, pp. 273–294, https://doi.org/10.4135/9781849200462.n13.
[44] O.P. John, E.M. Donahue, R.L. Kentle, Big five inventory, J. Pers. Soc. Psychol. (1991), https://doi.org/10.1037/t07550-000.
[45] J.M. Digman, Personality structure: emergence of the five-factor model, Annu. Rev. Psychol. 41 (1990) 417–440, https://doi.org/10.1146/annurev.ps.41.020190.002221.
[46] A. Ali, J.U. Haq, S. Hussain, A. Qadir, S.A.H. Bukhari, OCEAN traits: who shares more word of mouth? J. Promot. Manag. 28 (2022) 749–773, https://doi.org/10.1080/10496491.2021.2015510.
[47] K. Matzler, B. Renzl, J. Müller, S. Herting, T.A. Mooradian, Personality traits and knowledge sharing, J. Econ. Psychol. 29 (2008) 301–313, https://doi.org/10.1016/j.joep.2007.06.004.
[48] M.L. Korzaan, K.T. Boswell, The influence of personality traits and information privacy concerns on behavioral intentions, J. Comput. Inf. Syst. 48 (2008) 15–24, https://doi.org/10.1080/08874417.2008.11646031.
[49] M.A. Sanjeev, S. Khademizadeh, T. Arumugam, D.K. Tripathi, Generation Z and intention to use the digital library: does personality matter? Electron. Libr. 40 (2022) 18–37, https://doi.org/10.1108/EL-04-2021-0082.
[50] S.H.-W. Chuah, Why and who will adopt extended reality technology? Literature review, synthesis, and future research agenda, Lit. Rev. Synth. Future Res. Agenda Dec. 13 (2018) (2018), https://doi.org/10.2139/ssrn.3300469.
[51] M.E. Tabacchi, B. Caci, M. Cardaci, V. Perticone, Early usage of Pokémon Go and its personality correlates, Comput. Hum. Behav. 72 (2017) 163–169, https://doi.org/10.1016/j.chb.2017.02.047.
[52] S.-Y. Chien, K. Sycara, J.-S. Liu, A. Kumru, Relation between trust attitudes toward automation, Hofstede's cultural dimensions, and big five personality traits, Proc. Hum. Factors Ergon. Soc. Annu. Meet. 60 (2016) 841–845, https://doi.org/10.1177/1541931213601192.
[53] A. Narayan, A. Das, Understanding the level of trust in Twitter based on the three psychological facets - predictability, dependability and faith, in: 2019 11th Int. Conf. Commun. Syst. Netw. COMSNETS, 2019, pp. 399–402, https://doi.org/10.1109/COMSNETS.2019.8711430.
[54] C.C. Saw, A. Inthiran, Designing for trust on e-commerce websites using two of the big five personality traits, J. Theor. Appl. Electron. Commer. Res. 17 (2022) 375–393, https://doi.org/10.3390/jtaer17020020.
[55] R. Sternberg, R. Wagner, L. Zhang, Thinking Styles Inventory: Revised II (TSI-R2), Tufts Univ., 2007.
[56] R.J. Sternberg, L. Zhang, Styles of thinking as a basis of differentiated instruction, Theory Pract. 44 (2005) 245–253, https://doi.org/10.1207/s15430421tip4403_9.
[57] J. Fan, L. Zhang, The role of learning environments in thinking styles, Educ. Psychol. 34 (2014) 252–268, https://doi.org/10.1080/01443410.2013.817538.
[58] A.J. Flanagin, S. Winter, M.J. Metzger, Making sense of credibility in complex information environments: the role of message sidedness, information source, and thinking styles in credibility evaluation online, Inf. Commun. Soc. 23 (2020) 1038–1056, https://doi.org/10.1080/1369118X.2018.1547411.
[59] G. Pennycook, J. McPhetres, Y. Zhang, J.G. Lu, D.G. Rand, Fighting COVID-19 misinformation on social media: experimental evidence for a scalable accuracy-nudge intervention, Psychol. Sci. 31 (2020) 770–780, https://doi.org/10.1177/0956797620939054.
[60] F. Faul, E. Erdfelder, A.-G. Lang, A. Buchner, G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences, Behav. Res. Methods. 39 (2007) 175–191, https://doi.org/10.3758/BF03193146.
[61] K.-E. Chang, C.-T. Chang, H.-T. Hou, Y.-T. Sung, H.-L. Chao, C.-M. Lee, Development and behavioral pattern analysis of a mobile guide system with augmented reality for painting appreciation instruction in an art museum, Comput. Educ. 71 (2014) 185–197, https://doi.org/10.1016/j.compedu.2013.09.022.
[62] D.A. Briley, R.S. Wyer Jr., The effect of group membership salience on the avoidance of negative outcomes: implications for social and consumer decisions, J. Consum. Res. 29 (2002) 400–415, https://doi.org/10.1086/344426.
[63] A. Maass, M. Karasawa, F. Politi, S. Suga, Do verbs and adjectives play different roles in different cultures? A cross-linguistic analysis of person representation, J. Pers. Soc. Psychol. 90 (2006) 734–750, https://doi.org/10.1037/0022-3514.90.5.734.
[64] J. Lee, Trait desirability and cultural difference in the better-than-average effect, Asian J. Soc. Psychol. 15 (2012) 261–272, https://doi.org/10.1111/j.1467-839X.2012.01381.x.
[65] S.E. Cross, J.S. Gore, M.L. Morris, The relational-interdependent self-construal, self-concept consistency, and well-being, J. Pers. Soc. Psychol. 85 (2003) 933–944, https://doi.org/10.1037/0022-3514.85.5.933.
[66] C.K.W. De Dreu, Human creativity: reflections on the role of culture, Manag. Organ. Rev. 6 (2010) 437–446, https://doi.org/10.1111/j.1740-8784.2010.00195.x.