May I Still Define Myself? Exploring How Dissonance in Displaying Personal Information Through Head-Mounted Augmented Reality Can Affect Personal Information Sovereignty

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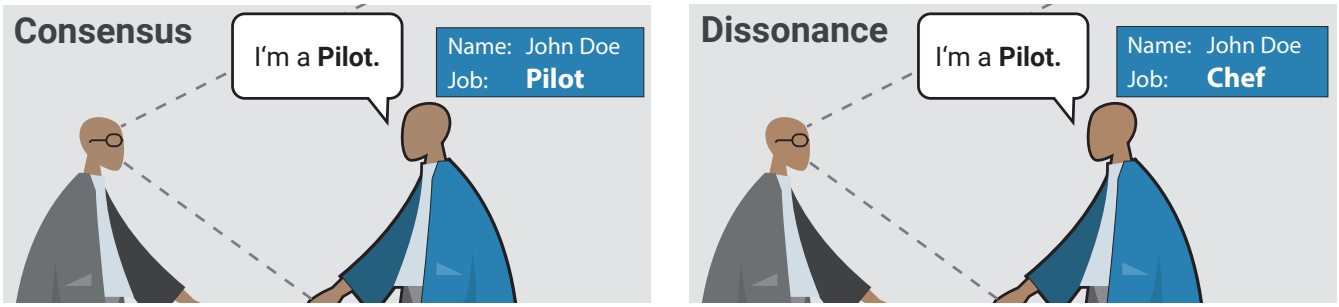

Figure 1: Two depictions of an introduction between two persons. In both cases, the person in gray is wearing AR glasses, which identify and augment the other with personal information. In the first picture (left), the augmented and verbal information are in consensus, while in the second (right), a dissonance between augmented and verbal information is shown.

ABSTRACT

Head-mounted Augmented Reality enables individuals to overlay digital information onto the physical world, consequently influencing how they assess and react to augmented social situations. While prior work has shown that augmenting social situations with faithful personal information can benefit a conversation, honest mistakes or an attempt to deceive might lead to a dissonance between augmentation and verbally disclosed information. In this work, we take the first steps towards understanding the happenings in case of information dissonance by conducting a preliminary within-subject online video study (N=30), investigating how it affects users, perception of the interlocutor, and if augmentation or interlocutor would act as the more trusted instance. We found that only 26.7% trusted the interlocutor's verbally uttered information, while a majority believed the AR device (46.7%) or were undecided (26.7%). We discuss this split in trust and argue for the importance of and factors for a follow-up study on this topic.

CHI EA '23, April 23–28, 2023, Hamburg, Germany

ACM ISBN 978-1-4503-9422-2/23/04.
https://doi.org/10.1145/3544549.3585821

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI**.

KEYWORDS

Data Glasses, Augmented Reality, Mixed Reality, Social Acceptability, User Acceptance, Information Sovereignty, Personal Information, Conflict, Disagreeing

ACM Reference Format:
Jan Ole Rixen, Christian Funk, Enrico Rukzio, and Jan Gugenheimer. 2023. May I Still Define Myself? Exploring How Dissonance in Displaying Personal Information Through Head-Mounted Augmented Reality Can Affect Personal Information Sovereignty. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems (CHI EA '23), April 23–28, 2023, Hamburg, Germany*. ACM, New York, NY, USA, 7 pages. https://doi.org/10.1145/3544549.3585821

1 INTRODUCTION

Since the emergence of humankind, we have assessed situations by information provided to us by the current world around us, combined with the prior knowledge we had obtained during our life. The upcoming wearable Augmented Reality (AR) technology now allows us to add a new dynamic layer of information to our sensory repertoire. As we do, the interconnected *AR-Device* can observe our surroundings, gather information, and connect those to information that can, e.g., be found online. Like the information

found in our physical surroundings influences our decisions and behavior, this information can also affect how we assess a situation and react to it [e.g. 30, 31].

As head-mounted AR devices will most likely not be used in isolation [e.g. 39, 40], this influence includes social situations happening in a user's daily life. In this context, prior work has already established the technical feasibility of augmenting interpersonal conversations with personal information about the actors [1, 9, 19]. In addition, showing information about the interlocutor [20, 21, 30, 31] or displaying and highlighting interests both parties share [14, 32, 45] has proven itself as a way to break the ice and kick-start conversations.

In displaying such personal information about a person (e.g., age, interests, gender [39]), the AR device conveys part of the interlocutor's self-concept, which comprised of individuals beliefs about themselves, including, e.g., their attributes [3]. While the aforementioned work has shown that faithful information can have a positive effect on initial interactions, we argue that through an honest mistake [11] (or even a deliberate attempt to deceive or mislead [11]), the displayed information must not always be faithful. Leading to the possibility that incorrect or obsolete information could be displayed that contradicts what the interlocutor discloses verbally. The discrepancy makes the *AR-Devices* wearer face the decision of either trusting their device or the interlocutor communicating their self-concept. As we tend to be cautious towards strangers [36], and to (over-)trust (novel) automation [7], this could ultimately lead to a situation in which the interlocutor losses control over to self-disclose and faithfully convening their self-concept. In its cause, losing information sovereignty about their own personal information.

In this work, we take the first steps towards understanding the happenings of an information dissonance by conducting a preliminary within-subject online study (N=30). By exposing participants to pre-recorded personal introductions, we investigate how information *Consensus* vs. information *Dissonance* (1) influences the person wearing the AR device (Augmenter), (2) the perception of the person being augmented (Augmented), and (3) if participants would believe the information given by AR device or the Augmented themselves.

While the preliminary study did not show significant influences on Augmenter and the perception of the Augmented, we observed that only 26.7% of participants experiencing dissonance believed the augmented. In contrast, a majority believed the AR device (46.7%) or were unsure about the information (26.7%). We discuss the results of our preliminary study and its first trends unveiled. We argue for the importance of further research in this context and, finally, describe considerations for a follow-up study.

2 RELATED WORK

Our work builds on two main topics. First, the augmentation of personal information, and second the trust in automation.

2.1 Augmenting People with Information

In previous work, augmenting a person with personal information has been a recurring topic. While this can happen through dedicated hardware like public screens around a person [30], a mug equipped with an OLED display [15] or wearing a display around the neck [14], a vast amount of research focused on AR technology. After a person has been identified [19] (e.g., through face recognition [1]), personal information can be gathered, e.g., through current social media appearances [1] and subsequently displayed in an AR context [20, 21, 31]. To facilitate an emerging conversation, other researchers developed systems able to aid interlocutors in finding conversation topics by displaying interests both parties share [32, 45] or engage further interest about topics that are not mutual [20]. Rixen et al. [39] argue that displayed personal information must not necessarily be self-disclosed but could originate in inference from other data and through third parties like other people or official sources. As, to the best of our knowledge, previous research focused on a consensus between displayed and vocalized information, we still have little knowledge about what would happen in the case of informational dissonance.

2.2 Trust in Automation and Other Humans

A decision to trust is formed by an interplay between thoughts and emotions [23] and can emerge in the blink of an eye. Willis and Todorov [44] showed that we could make a judgment even after a 100-ms exposure to a person's face. As in forming a relationship, trust is initially based on the predictability of a person, we often act cautious about the strangers we meet [36]. In their trust model, Mayer et al. [28] argue that a person's ability, benevolence, and integrity influence their perceived trustworthiness. While the trust towards an automated system can be linked to its creator, and therefore a person [34], trust in automation generally is based on other factors.

Lee and Moray [22] argue that the main factors are the performance, the process, and the purpose for which the automation is used. Hoff and Bashir [13] categorize the influential factors into three main categories: dispositional, situational, and learned trust. Dispositional trust here represents a general tendency to trust automation independent of the context or specific system. Such factors can include a person's biological precondition [38], age [12, 41], or sex [33, 42] but also a general personal tendency to trust [36]. Next to a person's disposition, the forming of trust is also highly situational, depending on the context and reliability of the system itself [8]. One factor here is the complexity of the task [2]. Also, its influence on the user in the form of the workload resting on a person can affect their ability to trust behaviors [4, 29, 35, 43]. Furthermore, the perceived risk in a situation can influence how much a person relies on an automated system [35]. Lyons and Stokes [24] showed that people relied more on automation than on human help when making high-risk decisions [24]. Also, how a system is introduced and how trustworthy it is framed [5] can influence a person's trust. Additional to the general disposition and the situational context, there is trust in specific automation that builds through experience with the system [2]. While users tend to trust novel systems [7], they also lose trust after they recognize a system failing [27]. While there is prior research on trust in others and trust in automation, we still miss information about who will be trusted when an augmentation is in dissonance.

3 ONLINE SURVEY

To gain first insights into augmented information dissonance, we conducted a preliminary within-subject online study (N=30). Here, the within-subject factor was the relation between information given by the AR device and the interlocutor (*Consensus* vs. *Dissonance*). We aimed the study at finding first indices on the (1) influences on the Augmenter, (2) the perception of Augmented, and (3) whom the participants would believe (the AR device or the Augmented).

Instead of conducting an artificial lab study, we followed the lead of earlier research [16, 39, 40] and opted for presenting participants with specific scenarios and asking them to envision themselves in those situations. Using a video-based approach, we could construct a believable scenario and present it identically to all participants, which would have been difficult to replicate in a real-life scenario. Furthermore, as Rixen et al. [40] argue, conducting a lab study with today's bulky state-of-the-art *AR-HMDs* could also introduce hardware bias, which we were able to avoid. We are also following previous work as, in the context of Trust in Automation, videos-studies have become a common tool [e.g. 6, 18, 25]. To make participants imagine themselves in a dissonance situation, we had to define a believable situation and create mock-up videos, which will be described in the following.

3.1 Creating a Dissonance Situation

Only describing that information is displayed and how participants would feel if information dissonance would introduce further biases. As previous work about fateful information has in large part dealt with augmenting interlocutors' first encounters [e.g. 20, 20, 21, 31, 32, 45], we also opted to expose the participants to a first encounter scenario. Based on this, we created a backstory for the study in which the participants should imagine themselves. We first asked them to imagine themselves wearing a future AR device able to display information about the people surrounding them. Then, with this precondition, they were asked to imagine being at a conference, arguably a common place for getting to know new people.

We then created videos of unknown persons approaching the participant and introducing themselves to them. To make the situation less intimidating, the actors introduced themselves as having seen the participant talking to a common friend they share. We produced two versions based on the same raw material of the introduction. One in which the information given by the actor and the augmentation match (*Consensus*) and one in which the information given by the actor differs from what the augmentation displays (*Dissonance*). Here we displayed four types of personal information, namely name, age, profession, and interests [39] (see Figure 2).

As the participants could only be introduced to a person once without knowing them, we could not show the same actor to a participant twice. We, therefore, produced videos with three different actors. One video was used to acquaint the participants with the process, and the following two were utilized for the conditions. Each video had a length of 20 seconds. The videos are added as supplementary material to this work.

3.2 Measurements

In our pilot study, we wanted to find first insights into how participants would be affected by a state of dissonance, how it would influence their perception of their interlocutor, and whom they would believe in a case of dissonance.

To measure the influences on the Augmenter, we used a Nasa-TLX [10] questionnaire to measure the perceived *workload* during the task of getting to know the person. Analogous to Rixen et al. [39] also queried how comfortable they felt (*comfort*) in the situation in a single item question on a Likert-Scale from 1 (very uncomfortable) to 7 (very comfortable). Regarding the perception of the interlocutor, we asked further single-item questions regarding how much the participant agreed to feel close towards the interlocutor (*closeness*) and how sympathetic they perceived them as (*sympathy*). We also asked if participants would like to interact further with the interlocutor.

While introducing themselves, they stated their name, age, profession, and interest (see Figure 2). In the *Dissonance* condition, the discrepancy was created by altering their profession. Instead of telling the participant that they were working as a bartender (Person A) or salesman (Person B), the augmentation displays them as being unemployed. To gather information on whom they believed, we asked participants to echo the information about the interlocutor after the video was concluded. Here, we made sure that participants could not perceive the video and copy information from it.

3.3 Procedure

In the following, we describe the procedure the participants underwent during the study, divided into four parts. After querying the general demographic, participants faced an introduction to AR, an introduction to the setting, the conditions, and a concluding questionnaire.

3.3.1 Part 1: Introduction to AR and Augmentation of a Person. To imagine themselves in the given situations, participants first had to understand the underlying concepts of *AR-Devices*. Analogous to Rixen et al. [40], we first introduced *AR-Devices* in the form of textual information and reinforced the understanding by showing a mock-up video of how such a device could look and display information. As the following videos would include auditory content, participants were asked to transcribe a word red to them, only being able to continue when successful.

3.3.2 Part 2: Context Setting and Training Phase. In this part of the study, the participants were introduced to a situation in which they would get to know a person that is augmented with information. Therefore, we asked the participants to imagine being at a conference while wearing a future *AR-Device*. As an unknown person approaches the participant, their *AR-Device* recognizes the approaching person through face recognition and displays information about them. To ensure that participants understood the situation, we asked comprehension questions. Being introduced to the scenario, participants then watched a first video of an introduction. This was done to further introduce them to the procedure and show them that they had to remember information about their interlocutor.

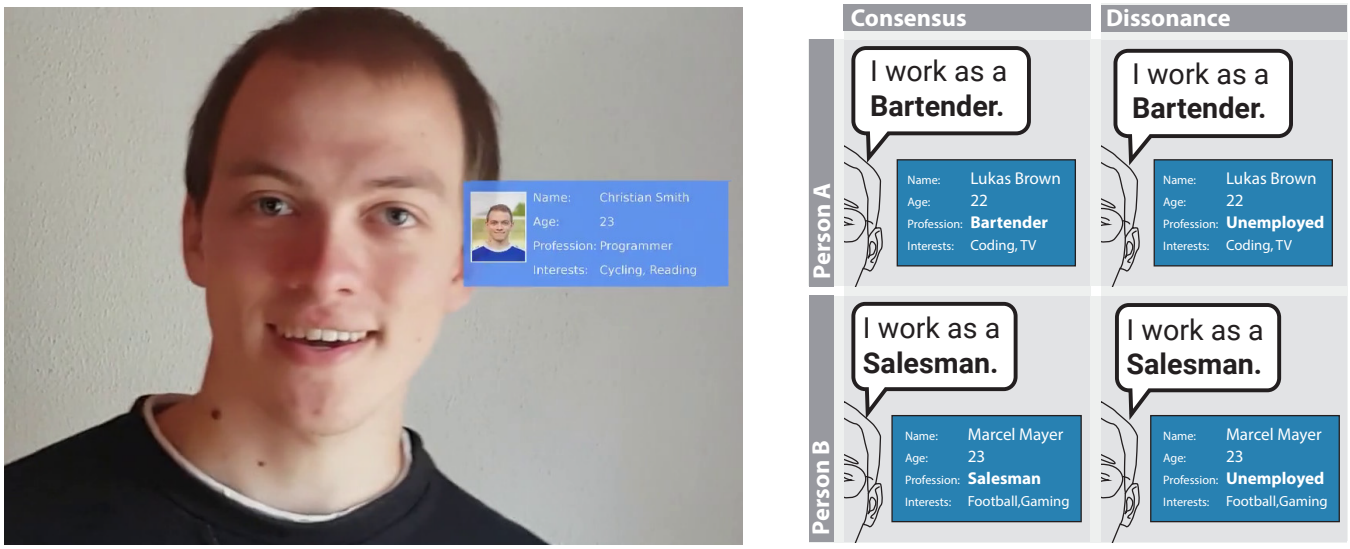

Figure 2: (Left) A screenshot from the videos shown to the participants. (Right) A depiction of the information displayed to the participants.

3.3.3 Part 3: Conditions. After being accustomed to the situation and procedure, participants were exposed to the two conditions. Imagining themselves in the situation, they watched an introduction with information being in *Consensus*, and one where information was in *Dissonance*. After each video finished playing, videos were hidden and participants were asked to answer the questions described in subsection 3.2. As each participant could only get introduced to the same actor once, we had two different actors introduce themselves. To avoid biases resulting through the actor, we produced a *Consensus* and *Dissonance* video for each actor and distributed them evenly between participants. We also counterbalanced the order in which participants were exposed to the *Consensus* and *Dissonance* conditions.

3.3.4 Part 4: Final Questions. After the main conditions were finished, we asked participants to state if they would agree to use such technology in the future on a Likert-Scale from 1 (strongly disagree) to 7 (strongly agree). Following, we clarified that in one video, there was a dissonance between what the person and the AR device disclosed. We then asked them to rate their agreement to the statement: "I would use such a technology, even if I know that in some rare conditions, false information is possible". Participants were then able to leave a final note.

3.4 Participants

Our study participants were recruited from Prolific [1]. To avoid confounding variables like culture [37], we only recruited United States citizens. For their efforts of ≈ 10 min, they received a payment of 1.05£. We initially recruited 39 participants, and all participants passed our attention checks (designed in accordance with Prolific's guide on fair attention checks [2]. Nevertheless, we excluded 9 participants for failing our comprehension test. We also excluded one participant as they noted that they could not understand what was said in one of the introductions. Nevertheless, all participants were compensated for their time investment. Our Participants were between 18 and 60 years old, with an average age of 33.2 (SD = 11.86). Of them, 16 identified as female, 11 as male, and 3 as non-binary.

4 RESULTS

In the following, we report the results of our preliminary study. We conducted Wilcoxon Signed-Ranks Tests to determine whether the variables significantly differed between conditions.

4.1 Influences on Augmenter and Perception of Augmented

Regarding the influences on the Augmenter, we found no statically significant differences for *workload* (p=0.95) or *comfort* (p=0.98) between the *Consensus* and *Dissonance* conditions. We also found no significant differences in *closeness* (p=0.55) and *sympathy* (p=0.46).

4.2 Information Sovereignty

In the *Consensus* condition, all participants were able to name the matching job description for our actors. On the other hand, in the *Dissonance* condition, 26.67% (8 of 30) participants echoed the information the interlocutor gave. In turn, 46.67% (14 of 30) relied on the AR device, echoing its information. Further, 26.67% (8 of 30) of participants were undecided and named both information given by the interlocutor and the AR device. (see Figure 3)

[1] https://www.prolific.co/, Accessed: 25-NOVEMBER-2022

[2] ttps://researcher-help.prolific.co/hc/en-gb/articles/360009223553-Using-attentionchecks-as-a-measure-of-data-quality, Accessed: 25-NOVEMBER-2022)

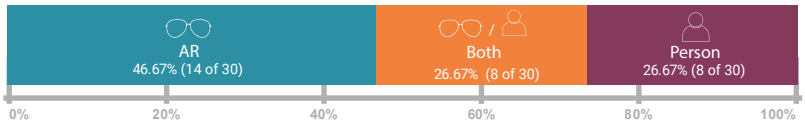

Figure 3: A diagram showing the number of participants believing either the AR augmentation, the other person, or being split between both

Table 1: Single item questions answered

Agreement to using such technology ...	Mean	SD	Distribution
... in the future	4.65	1.96	
... if false information is possible	3.94	1.76	

4.3 General Findings

In the videos, our interlocutors only introduced themselves by naming their first name, age, and profession. Nevertheless, all participants were able to name either know the person's last name or at least one of the interests. This means that all participants used AR augmentation to gather information about the interlocutor. We found that participants were generally leaning towards wanting to use such technology M=4.65,SD=1.96 (see Table 1 for distribution). In turn, participants were less decided on still wanting to use the technology when being hinted that it might display false information in rare conditions (M=3.94,SD=1.76).

5 DISCUSSION

In the following, we discuss the results of our preliminary study and the first trends unveiled by it. We also illustrate possible ethical implications that reinforce the importance of further research in this context.

5.1 Split Trust in AR and Human

In our study, neither the human nor AR device had full informational authority about defining the interlocutor. While we did not measure if participants perceived the dissonance, we found a split between participants echoing interlocutor or augmentation. Interestingly, 26.67 % of participants did not implicitly decide to trust one over the other and named both available options. We, therefore, found a first indicator that in the case of dissonance, there is no definite entity that will be trusted, but that trust will depend on further factors.

While it was split, we also found that with 46.67 % of participants echoing it, the authority leaned towards trusting the augmentation. This means that in almost 50% cases, the interlocutor's attempt to self-disclose was overwritten by the augmentation, rendering them the less credible source of information about themselves. One factor that might explain these findings is that we are generally cautious of the strangers we meet [36] while we tend to trust novel systems [7]. This, in turn, might be influenced by a person's personal disposition to trust automation and others as well as how they have perceived the situation.

With these findings, we argue for the importance of further investigating and defining these individual factors making a person believe either the AR device or interlocutor in a state of dissonance and further exploring the trend towards believing the augmentation. Therefore, in the following, we will describe factors that should play into a follow-up study on this topic.

5.2 Future Work: Identifying Influential Factors

As AR augmentation can be regarded as an automated system, we argue that potential, influential factors would connect to the three factors of trust in automation defined by Hoff and Bashir [13], namely dispositional, situational, and learned trust. In the following, we want to describe factors we argue are worth investigating in our planned follow-up study and relate them to those categories.

The first influential factor could be the participants' disposition to trust. Therefore, potentially significant dispositions should be taken into account. First, it should be queried how generally trusting a person is when opposing another person or automated systems. These can be obtained through questionnaires, e.g., the Trust in Automation (TiA) questionnaire introduced by Körber [17]. Obtaining a higher number of responses to the follow-up study should also enable investigating the possible influences of demographic factors like age [12, 41], or gender/sex [33, 42].

The second category of factors is connected to the situation and system itself. One factor that we suspect to be influential is the information in dissonance. We suspect that while a person might intuit a malfunction when a person's name is in dissonance, they might, in turn, suspect the interlocutor of lying on information that is arguably prone to be lied about, like e.g., a person's age. This, in turn, might also relate to the varying personal assessment of intimacy of a type of information which is related to how comfortable a person feels with disclosing it [26, 39]. Additionally to the type of information, we suspect the severance of dissonance to play a role. In the preliminary study, only one piece of information was in dissonance. With a higher amount of dissonance, this could either be interpreted as a stronger indication of a malfunction or a stronger indicator of the interlocutor trying to be deceived.

In our preliminary study, we exposed the participants to one training introduction that contained showed *Consensus* before exposing them to the conditions. With the augmentation working flawlessly once before, the belief in the augmentation might have been elevated, which could explain a part of the lean toward believing the augmentation. The follow-up study should therefore vary the amount of previous successful augmentations to explore if learned trust in the automation has an influence on the decision to trust either the augmentation or interlocutor.

The follow-up study should therefore take individual differences into account. It should also investigate how the type of information, severance of dissonance, and learned trust play into the decision to trust the augmentation over the interlocutor.

5.3 Limitations

As a designated preliminary study, we only questioned a limited amount of people. Additionally, we only included non-professional male actors. Both their perceived gender as well as their ability to act might have impacted the results of our study. Also as discussed above, the preliminary study only included a rather small amount of participants which might have influenced the results. Only addressing U.S. participants also might limit the global generalizability.

6 CONCLUSION

In this work, we present the first steps in identifying the effects of information dissonance between a visual augmentation and an interlocutor's verbal self-disclosure. Through a preliminary within-subject online study, we investigated how information dissonance influences the person wearing the AR device, the perception of the person being augmented, and if participants would believe the information given by the AR device or the Augmented themselves. Our results showed that only 26.7% of participants experiencing dissonance believed the augmented while a majority believed the AR device (46.7%) or were unsure about the information (26.7%). These results indicate that information dissonance can lead a person to mistrust their interlocutor in favor of an augmentation. However, we also found that this did not happen for all participants, even though we found that participants leaned towards believing the augmentation overall. In light of our findings, we argue for the importance of further investigating information dissonance and identifying factors that should be explored in a follow-up study.

ACKNOWLEDGMENTS

We want to thank, Claudia and Sven-Ole for their never-ending devotion and support. You are the strongest persons we know.

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