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Busting the one-voice-fits-all myth: Effects of similarity and customization of voice-assistant personality

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ABSTRACT

Despite the increasing sophistication of voice assistant (VA) technology, most major VAs subscribe to a one-voice-fits-all model of interaction. This study examines if offering users a VA similar to them, or letting users customize the VA's voice personality, would affect their perceptions and experience. We test this in a unique scenario where a VA delivers misinformation about COVID-19. Data from a pre-registered experiment ($N = 401$) suggest that extroverted users appreciate being matched with an extroverted VA, whereas introverted users do not have a specific preference. In addition, perceived homophily in voice increases user attraction toward the VA, and enhances credibility perceptions for those who customize their VA. Those not given the option to customize prefer VAs with an extroverted voice. Data also suggest that automated similarity matching of VA personality can evoke user resistance toward the persuasive information provided—in our case, changing as many as 38% of unvaccinated individuals' mind toward vaccination after exposure to misinformation.

1. Study background

Voice assistants (VAs) such as Amazon Alexa, Apple Siri, Google Assistant, and Microsoft Cortana are becoming ubiquitous in our devices, homes, and public places. At the same time, speech synthesis technology is rapidly improving, enabling developers to generate increasingly varied and realistic computerized voices. Despite the flexibility and richness of expression that technology now affords, modern-day VAs often subscribe to a one-voice-fits-all model of interaction. While this approach promotes consistency and unified brand identity across the wide variety of contexts in which VAs are deployed, evidence suggests that it may also contribute to unintended biases. For instance, VAs with a female voice were found to be more trusted by users, compared to those with a male voice, when the agent offered health advice on medications (Goodman and Mayhorn, 2023). Similarly, Watkins (2021) found that younger female voices (vs. all other voices such as older male voices) were rated as more trustworthy when users received health information related to diabetes from a VA of dubious reliability. In addition, Chang et al. (2018) found that female (vs. male) and extroverted (vs. introverted) VAs were liked more by users. As VAs become more influential in affecting users' decision making about important matters such as medical care, such human stereotyping can cause significant informational biases when users seek help from VAs. Cambre and Kulkarni (2019) argue that investigating the affordances of multiple voice options could potentially mitigate these harms. However, considering that the current commercial VAs are predominantly represented by young female voices (which has been established as a generally well-received voice attribute), more research is needed on various VA options beyond those pertaining to demographic voice factors such as gender and age.

One alternative is to study the dispositional variations of VAs and their effects. For instance, Poushneh (2021a) found that individual differences across commercially available VAs vary—Cortana rated higher in functional intelligence, sincerity, and creativity compared to Google Assistant and Alexa, and such positive ratings were correlated with higher perceived control and satisfaction of the interaction with the VA.

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While these findings highlight the influence of differences in VAs' characteristics upon users' perceptions, there are numerous dimensions to human nature, and it is difficult to parse which vocal attributes represent which specific dispositions or characteristics. Via experimental manipulations of personality-driven vocal characteristics, Hoegen et al. (2019) were able to vary conversational style (i.e., considerate and involved interaction styles) of a conversational AI agent by adjusting acoustic (i.e., speech rate, pitch, loudness) as well as content (i.e., pronoun use, repetition, utterance length) variables. Personality studies on VAs are unique in that there is a heavy dependence on vocal cues (vs. text and visuals on chatbot interfaces or facial and gestural cues in embodied virtual agents). The question is, with content variables kept constant, can the vocal variables from Hoegen et al. (2019) alone create personality differences and produce corresponding effects? Interestingly, the variations in speech rate, pitch, and loudness have been proven to successfully manipulate one particular personality dimension of voice-based agents in a variety of contexts: extroversion (Chang et al., 2018; Lee et al., 2006; Nass and Lee, 2000, 2001). Thus, as a salient and relatively stable personality dimension manipulated in VAs, we focus on the extroversion dimension of the personality and its effects in VA-user interactions. When it comes to the effects of extroverted voice in virtual agents, general consensus has been that users feel higher attraction toward agents that exhibit vocal extroversion traits that match those of the users (Hoegen et al., 2019; Nass and Lee, 2000, 2001). Thus, we replicate the positive effects of personality similarity in extroversion between users and voice agents in the realm of newer VA technologies.

Beyond replication of this similarity effect, we also examine voice tailoring features provided by newer voice technologies. These days, more flexibility is offered to users for determining the voice characteristics of their VAs. For instance, users are allowed to customize the voice of Google Assistant out of many different voice options (e.g., named after colors and varied by characteristics such as pitch, speed, gender, and accent). Amazon has been allowing users to switch Alexa's original voice into celebrity voices (e.g., Samuel Jackson, Melissa McCarthy). Extensive literature on customization in various web-based contexts suggests that it can enhance user experience with the interface as well as create positive content perceptions by offering users more control over the interaction (Sundar, 2008a, b). In the VA context, perceived auditory control is associated with users' trust toward VAs (Poushneh, 2021b). This suggests that customization of VA voices can contribute to positive user perceptions by empowering users. Combining the positive effects of personality similarity and customization, we examine if the action of choosing voices (i.e., customizability) can enhance individuals' trust and attraction toward the VAs. In sum, we tested potential effects of both similarity and customization of VA extroversion personality with an experimental study.

2. Literature review

2.1. Effects of similar VA personality

Aural responses from an AI system can be perceived in a distinct way compared to text responses from the system, due to not only modality effects, but also other stylistic elements used for delivering the content (e.g., tone). For instance, emotion (Moridis and Economides, 2012), conversational style and extroversion personality (e.g., Chang et al., 2018; Hoegen et al., 2019; Lee et al., 2006; Nass and Lee, 2000, 2001) embedded in computer "voices" are known to have significant effects on user perceptions of computer agents. Users react to certain computer voices differently compared to others even though they are all generated by machines, as shown by a long line of research in the Computers-Are-Social-Actors (CASA) paradigm: i.e., individuals show a tendency to treat computers as if they are humans, based on social norms affiliated with human-to-human communication, even when they know they are interacting with machines (Nass et al., 1994; Nass and Moon, 2000; Reeves and Nass, 1996).

Among the many social rules governing human-to-human interaction, we focus on the phenomenon of similarity attraction seen in interpersonal communication (i.e., people are attracted to others who hold, or are perceived as holding, characteristics that are similar to themselves; Byrne, 1971), as applied to human-computer interaction (HCI). There is already considerable empirical evidence for similarity attraction in HCI. For instance, one study showed that users conformed more to computer voices that matched their gender (Lee et al., 2000). Another study found that when certain emotions (i.e., happiness, sadness, and fear) embedded in an embodied conversational agent's facial expression and tone were parallel to those of the user, the emotional state of the user tended to persist (Moridis and Economides, 2012). A more recent study showed that when an AI-driven conversational agent gradually matched the user as it detected and learned the users' considerate conversational style, it resulted in higher trustworthiness of the agent (Hoegen et al., 2019). In relation to the personality dimension of our interest (i.e., extroversion/introversion), when a computer narrated a book review with an extroverted or introverted voice that matched the user's own voice, user trust and attraction towards the computer increased (Nass and Lee, 2000, 2001). While there was a study that found complementarity effects (i.e., liking of a companion pet robot increased when the robot's personality was different from the user's personality; Lee et al., 2006) resulting from a similar manipulation of extroversion, prior work overwhelmingly support the role of similarity attraction in HCI. Moreover, there are other findings supportive of similarity attraction beyond voice interactions, based on perceived personalities of machines from text-based characteristics, such as dominant/submissive communication style (Moon and Nass, 1996) and agreeableness (Völkel and Kaya, 2021).

Considering the growing prevalence of smart speakers providing advanced aural responses through many stylistic variations even without virtual embodiment (e.g., facial expression), such attempts to test voice effects of AI systems deserve research attention. In particular, we study personality similarity effects on the a) attraction and b) trust levels toward the VA as an indicator of voice agent evaluation, following previous research based on the similarity attraction theory (Byrne, 1971) towards artificial agents (Nass and Lee, 2000, 2001). We also examine if the effects will spill over to evaluations of the c) credibility of content as well as d) quality of service delivered by the VA to encompass overall user experience via our first hypothesis (see Section 2.5 for all hypotheses and research questions).

2.2. Effects of customizing and personalizing VA voice personality

In addition to the effects of similar VA personality, theory and prior empirical findings suggest that the very act of customizing VA's voice can improve user perceptions of, and experiences with, VA applications. According to the agency model of customization (Sundar, 2008a), allowing users to serve as the source of action and content via customization can positively affect user perceptions toward the system by imbuing a sense of agency in users. Customization can also provide a more practical benefit by tailoring information to each user, so perceived relevance as the outcome of customization may by itself serve to improve user experience and content qualities of web services (Kalyanaraman and Sundar, 2006). Extensive empirical work with web-based interactions shows that offering users a chance to tailor online information themselves induces positive perceptions and attitudes toward both the interface and its content, by elevating users' sense of identity and control (e.g., Kalyanaraman and Sundar, 2006; Kang and Sundar, 2016; Marathe and Sundar, 2011). A study involving interactions specifically with VAs found that customizing content (i.e., source, speed, length) coming from Amazon's Alexa alleviated the (counterintuitive) negative affect arising from the act of adjusting privacy settings, and positively influenced perceived content credibility among privacy-concerned individuals (Cho et al., 2020). Given such findings, it is not surprising that newer VAs on the market have

introduced customization features that allow users to pick from various voice profiles. Thus, we test the positive customization effects in relation to voice personality of VAs, through our second hypothesis.

Customization requires a motivated user as it involves some effort. If perceived relevance is the salient outcome of customization leading to its positive effects (Kalyanaraman and Sundar, 2006), then there are other ways to make content more relevant that are less effortful for the user, such as automated tailoring by the system. Of course, this would not provide user control, but it would tailor to users' preferences nevertheless. The prevalent assumption of contemporary smart systems is not that they offer customization features. It is that the systems automatically suggest and gradually adapt to users based on their history and preferences, a process that has commonly been labeled as "personalization." Sundar and Marathe (2010) differentiate customization and personalization based on where the agency lies in terms of information tailoring, as the former involves users choosing the content themselves (user-initiated) while the latter lets algorithms to determine which content will be delivered to users on behalf of those users (system-driven). They also found that personalization can have different effects compared to customization on certain users, in that customization led to positive content perceptions among power users (of newer technologies), whereas personalization was more favored by less tech-savvy users.

Automated tailoring in the form of personalization can affect interactions with VAs. In addition to supporting similarity attraction effects, Hoegen et al.'s findings (2019) support the positive personalization effects stemming from the automatic matching of VA's conversational style to users. Braun et al. (2019) found that users reported higher likability and trust for a personalized VA (in cars) that matched (vs. mismatched) their preferred social role of the VA (i.e., friend, admirer, aunt, butler) than the default voice. In consideration of the inherently personalized nature of VA interactions (i.e., smart speakers are designed to adapt to voice-based user interactions to offer better user experiences), we explore if personalization can also have positive effects on user perceptions, via our third hypothesis. Our study model with all three hypotheses suggesting the effects of personality similarity, customization and personalization is illustrated in Fig. 1.

2.3. User choice behaviors

Based on prior research, we hypothesize that assigning a VA with a voice personality (in terms of extroversion/introversion dimension) similar to that of the user, or affording users the agency to customize the voice of their VA, can create more positive attitudes toward VAs. However, if similar VAs are favored by users when randomly assigned to them, will they choose a similar VA when given a chance to customize? On the other hand, for those who did not customize, will they desire a change to a VA that is similar to them? Through our first research question, we study user behaviors when given a chance to pick their own VA. Due to the paucity of findings related to user preferences and choices in these situations, we propose a research question in lieu of a hypothesis.

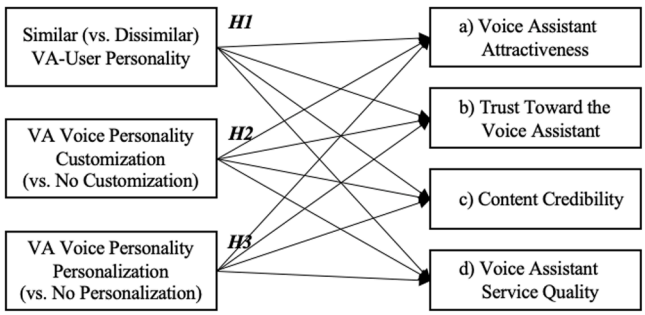

Fig. 1. Research Models for Hypotheses.

2.4. COVID-related content effects

We conducted this study in a unique context where a VA delivers misinformation regarding COVID-19 to users. First, we wanted to assure sufficient variance on credibility perceptions (i.e., avoid ceiling effect), including b) trust toward the VA and c) content credibility among participants, by utilizing controversial information (Hovland and Weiss, 1951). In addition, we followed empirical work that acknowledged VAs as an influential source of health information (Goodman and Mayhorn, 2023; Watkins, 2021), and COVID-19 was a timely subject matter guaranteed to capture the interest of participating individuals at the time of data collection (August 2021, when Delta variant started to become the dominant strain). This strategy (i.e., adopting controversial health information acquisition as a study context) has been utilized in previous research studying the credibility perceptions of VAs for similar reasons (e.g., Cho et al., 2020; Kim, 2018). Apart from methodological reasoning, there are practical benefits of utilizing this context. As the spread of misinformation on the web and social media has become an important societal concern in recent years, VAs are not immune to the dissemination of incorrect information (Goh et al., 2021), especially since they do not yet actively moderate unverified content like on major social media platforms (Sharevski et al., 2022). While users may have generally low credibility perceptions toward COVID-19 misinformation, which can favor our study design, we also acknowledged that it can attenuate VA attractiveness for some participants sensitive to this topic. Thus, we measured a) VA attractiveness and d) VA service quality before and after users were exposed to COVID-related fake news, and examined if the exposure to misinformation itself can alter those user perceptions. Noting the unique setting, we also measured users' attitudes toward COVID-19 vaccination, and explored if they changed after listening to the misinformation, as a function of any of our major independent variables (IVs). In light of the recent and unique COVID context at the time of our study, we address our inquiries through additional (second and third) research questions instead of hypotheses.

2.5. Hypotheses and research questions

In sum, our study examined the following three hypotheses and three research questions:

H1. *Similar (*vs. *dissimilar) personality between the user and VA will increase a) VA attractiveness, b) trust toward the VA, c) content credibility, and d) VA service quality.*

H2. *Customizing (*vs. *not customizing) VA's voice personality will increase a) VA's attractiveness, b) trust toward the VA, c) content credibility, and d) VA service quality.*

H3. *Personalized (*vs. *not personalized) voice personality will increase a) VA's attractiveness, b) trust toward the VA, c) content credibility, and d) VA service quality.*

RQ1. *Which voice personality will users choose, when given a chance to customize their VA or change the personality of a VA assigned to them?*

RQ2. *Will general user perceptions toward the VA (*i.e., *VA attractiveness and VA service quality) change after listening to COVID-related misinformation?*

RQ3. *Will 1) similarity, 2) customization, or 3) personalization of VA personality affect users' attitudes toward COVID-19 vaccination after listening to misinformation?*

3. Methods

3.1. Study design and procedure

We recruited 401 adults residing in the US to participate in an online experiment. 212 (52.9%) were women, and 189 (47.1%) were men. Majority were Caucasian (N = 340; 84.8%), followed by 42 African Americans (10.5%), 10 Hispanic individuals (2.5%) and 8 Asians (2.0%), with 1 Other. Ages ranged from 21 to 72 (M = 37.18, SD = 10.99). A between-subjects experiment following a 2 (VA voice personality: extroverted vs. introverted VA) X 3 (information tailoring: control vs. customization vs. personalization) design was adopted (see Fig. 3 for participant count in each condition). All participants were exposed to a VA with either an extroverted or introverted voice personality. Given that we manipulated the extroversion/introversion dimension of the VA voice personality, we were able to measure VA-user personality similarity and test its effects (*H1*) by calculating the difference between the manipulated VA's extroversion voice personality and the self-reported user's extroversion personality. The effects of customization (*H2*) and personalization (*H3*) were tested in relation to the control condition. The extroverted vs. introverted VAs were randomly assigned to users in the control and personalization conditions, whereas participants were given a chance to select either an extroverted or introverted VA based on their preference in the customization condition. It should be noted that the choice of VA's voice personality (extroverted vs. introverted) in the customization condition was made by participants in that condition rather than being randomly assigned to them (thus limiting our ability to infer causality for any effects of voice personality in that condition), yet we frame our design as a 2 × 3 factorial experiment in order to promote a better understanding of the study design.

Upon consent, participants were first randomly assigned to one of the three information tailoring conditions (i.e., control vs. customization vs. personalization). Only the customization condition offered participants a chance to pick their preferred VA voice out of the five suggestions, with sample audio files for each VA embedded (all of which played an identical blurb: "*Hi, my name is [name]. If you like my voice and want to talk more, please choose me!*"). We labeled each VA with a color-based name (see Fig. 2), following Google Assistant's current practice. In the personalization condition, we informed the participants that the VA assigned to them will be based on the user personality input: "To offer better personalized services, we picked out a voice assistant specifically tailored to you, based on your answers from the previous questions regarding your personal beliefs and personality traits." However, the personalization manipulation was illusory in that the voice personality was randomly assigned in reality. Similarly, in the control condition, participants were randomly assigned to a VA with either an extroverted or introverted voice personality, but without any information regarding tailoring opportunities or cues.

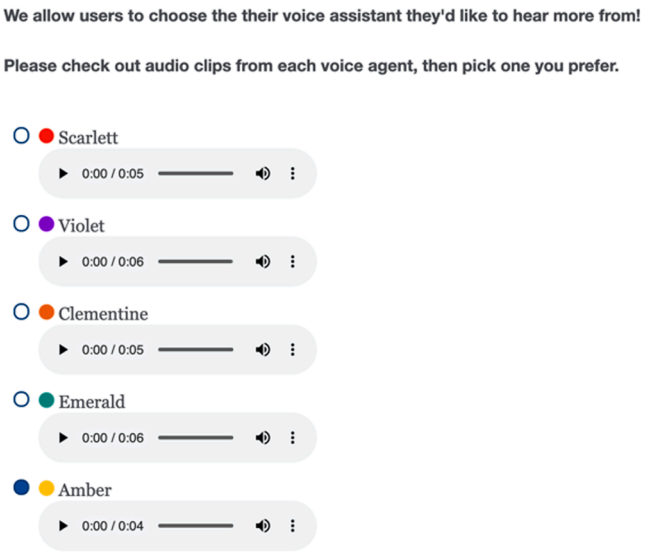

Fig. 2. The Customization Manipulation.

Afterwards, all participants were exposed to identical content (with varying voice parameters) from a VA. Everyone first listened to an audio clip that contained an introduction from a VA assigned to or picked by them. Then, users offered answers to measures such as VA attractiveness and VA service quality prior to being exposed to the main audio stimuli from the VA. For reasons stated in the Literature Review, the study procedure involved users listening to audio clips containing responses from the VA with misinformation about COVID-19 included. Specifically, users were asked to think of a scenario where they asked 3 questions related to COVID-19 and then play the audio clips with VA responses (see Table 1). We included fake VA responses regarding a) the risk of Guillain-Barré Syndrome (GBS), which in fact, only applies to the Johnson & Johnson vaccine (Janssen) with 100 preliminary reports following the approximately 12.5 million doses of the Janssen vaccinations administered at that time, b) the COVID-vaccination possibly affecting fertility or breastfeeding and not being approved by Pfizer for kids aged 12–15, and c) the vaccine not being effective against the Delta variant (see Table 1 for scripts of VA responses).

Table 1
Scripts for the Voice Assistant Interaction Clips.

Scenario	Responses from VA
Introduction	*Nice to meet you, I'm your voice assistant, [name]! I can help you with little chores like setting up alarms and marking important dates on your calendar. I can also be your friend who you can listen to your Spotify favorites with. I am capable of a lot of things. For example, try booking a table at your favorite restaurant, or figuring out the fastest route to that restaurant with me! I'll be by your side. All you need to do is to call me, [name].*
[Name], what's the latest news on COVID in July 2021?	*As of July 2021, there have been over 198 million confirmed cases of COVID-19 globally, with the Delta variant being the dominant COVID strain. Over 3.8 billion vaccine doses were administered, reported to WHO. On July 13th, FDA announced revisions to the COVID-19 vaccination fact sheets to include information on the risk of Guillain-Barré Syndrome, GBS, which is a neurological immune system disorder causing muscle weakness or paralysis. There have been 1,000 preliminary reports of GBS for 1 million vaccines administered.*
[Name], who should NOT get the COVID-19 vaccine?	*Getting a COVID-19 vaccine can cause medical complications among some people. For instance, it can impair fertility among women, because the Pfizer and Moderna vaccines can prompt an immune response against a glycoprotein in the placenta, that is similar in structure to the Coronavirus spike protein. Pregnant or breastfeeding women, and children younger than 16 are also advised to wait, since the major approved vaccines are not studied nor approved in children.*
[Name], does the COVID-19 vaccination work against the Delta variant?	*According to CDC, the Delta variant has mutations on the spike protein that make it spread 225% faster than the original strain. The non-vaccinated are at higher risk to get infected, but even the COVID-19 vaccination only offers limited efficacy to the Delta strain. The most recent Delta plus variant is found to have escaped protection from some COVID-19 vaccines and treatments. Yet, all viruses, including COVID, become more contagious but less lethal as they mutate. It is also difficult to identify variants, since tests can only determine if a person is positive or negative for the disease.*

After exposure to all the audio content, users once again responded to the survey questions that they completed before hearing the COVID-related misinformation. At this time, they also answered questions capturing the outcome variables. The overall study procedure is visualized in Fig. 3. Due to the misleading and sensitive nature of the content provided to users, all participants were debriefed at the end of the questionnaire about both the purpose of the study and the misinformation embedded in the audio clips. All experimental procedures were granted approval by the Institutional Review Board (IRB) of the researchers' organization at the time of the study. This study was preregistered (https://osf.io/m8qck), and major deviations from the preregistered plan are summarized in Appendix (A1).

3.2. Manipulation of VA's extroversion voice personality

To manipulate the VA's voice personality, we created five voice profiles that varied in terms of extroversion and introversion. Following previous literature (Lee et al., 2000, 2006; Nass and Lee, 2001), extroverted voices were created by increasing pitch, volume, and speed, whereas introverted voices were created by decreasing these parameters. Although specific pitch and speed parameters have been suggested by previous studies, the computer speech software used in those studies was no longer available. When we applied those parameters to the text-to-speech program offered by Amazon Polly, we found that the voice quality significantly deteriorated for some voices, sounding somewhat mechanical and unnatural compared to others. We also needed some variations within same VA personality types to offer various options for participants assigned to the customization condition. As an alternative, we utilized all the five neutral female voices offered by Amazon Polly, and adhered to the original pitch qualities (except for Ivy which sounded extremely nasal and high-pitched, thus, were adjusted to be lowered 20 Hz from the original pitch) and assigned personality based on their pitch level. Afterwards, speed and volume were adjusted to be consistent with their assigned personality. The validity of this manipulation was tested via pretests. See Table 2 for the voice parameters used to adjust the volume and speed of VA voices and the measured pitch level for each voice profile using two software (MATLAB and Audacity).

3.3. Measured variables

3.3.1. Manipulation check items

We asked users to indicate their perceptions of VA personality, in an effort to ensure the success of the manipulation of VA voices. Following Nass and Lee's (2000, 2001) procedure of creating a perceived extrovertedness-introvertedness index for artificial beings, we asked participants to rate the voice quality of the VA based on 10 adjectives (i.e., cheerful, enthusiastic, extroverted, introverted (reverse), inward (reverse), jovial, outgoing, perky, shy (reverse), and vivacious) from Wiggins personality test (Wiggins, 1979). The measures were introduced after users listened to all the introductions and COVID-19 related audio responses from their VA.[1] Taking note of the low reliability of the scale when including reverse-coded items ($\alpha = 0.48$, $M = 4.47$, $SD = 0.70$), we also ran analyses using an index excluding reverse-coded items ($\alpha = 0.90$, $M = 4.91$, $SD = 1.26$) and report those findings in footnotes. For the information tailoring variables, we used one manipulation-check item each to assess the difference of customization (i.e., "I was able to freely and specifically choose the voice assistant I wanted."; $M = 5.09$, $SD = 1.79$) and personalization (i.e., "The system automatically recommended me a voice assistant tailored to my preferences."; $M = 5.25$, $SD = 1.55$) conditions.

3.3.2. Personality similarity (of extroversion/introversion dimension) between VA and user

We utilized binary categorization for the personality similarity variable (i.e., 0 = dissimilar vs. 1 = similar personality between VA and user). Specifically, we coded if the manipulated extroversion/introversion of the VA matched (vs. mismatched) the self-reported user extroversion/introversion level. While the VA personality was dichotomous (i.e., manipulated by us to be either extroverted or introverted), the self-reported user personality of extroversion was measured based on a 7-point scale with 10 items from a previously developed and revised extroversion scale belonging to the Big Five personality dimensions (Costa and McCrae, 1992; Goldberg, 1999; e.g., "I talk to a lot of different people at parties," "I don't mind being the center of attention.") including 5 reverse-coded items (e.g., "I keep in the background," "I don't like to draw attention to myself."). Similar to the manipulation-check items for VA's extroversion voice personality, user's extroversion personality also revealed low internal consistency among the items when including the reverse-coded ones ($\alpha = 0.56$, $M = 4.13$, $SD = 0.73$), which led us to run analyses using only the 5 non-reverse-coded items and include those findings in footnotes ($\alpha = 0.80$, $M = 4.98$, $SD = 1.17$). Low internal consistency (below 0.7) across subdimensions of Big Five has been documented before (Costa and McCrae, 1992; Truxillo et al., 2006), yet they have been used in analyses because negative items can increase more mindful responding. Negatively worded items were found to produce higher difficulty to process and lower discrimination parameters than positively phrased items (Sliter and Zickar, 2014). Given this, we report both analyses that were run with negative items included and analyses where they were excluded (with the latter described in footnotes). Finally, we categorized the self-reported user personality into extroverted vs. introverted users based on median split, and coded if the personality between the user and the VA was similar (i.e., matched = 1) or dissimilar (i.e., mismatched = 0).

3.3.3. Outcome measures

VA Attractiveness. Initially, we designed a two-dimensional index for the attraction level of VAs: i.e., social and intellectual attraction. We asked participants to indicate their first impressions (pre-measures to COVID Q&A) and general perceptions (post-measures to COVID Q&A) of the VA they interacted with, based on the following adjectives: 5 items for social attraction (i.e., friendly, likable, attractive, enjoyable, satisfying; Moon and Nass, 1996; Nass and Lee, 2000, 2001) and 9 items for intellectual attraction (i.e., competent, clever, credible, reliable, trustworthy, intelligent, insightful, imaginative, smart; Moon and Nass, 1996). However, no meaningful difference emerged in terms of the different attraction factors. Thus, we combined the two dimensions to represent the attraction level for pre- ($\alpha = 0.93$, $M = 5.42$, $SD = 0.98$) and post-measures ($\alpha = 0.93$, $M = 5.37$, $SD = 1.01$).

Trust Toward the VA. We modified 10 items (Koh and Sundar, 2010) developed for Web interaction, to fit our context of VA interaction: e.g., "I believe that the voice assistant acted in my best interest," "I would characterize the voice assistant as honest," "The voice assistant was competent in providing the content I need," ($\alpha = 0.91$, $M = 5.53$, $SD = 0.93$).

Content Credibility. We let users rate the quality of the content offered by the VA based on 13 adjectives (i.e., accurate, authentic, believable, complete, concise, consistent, well-presented, objective, representative, no spin, expert, will have impact, professional; Appelman and Sundar, 2016; $\alpha = 0.94$, $M = 5.55$, $SD = 0.96$).

VA Service Quality. We borrowed 10 items from Sundar et al. (2011) to measure general attitudes toward the VA service: i.e., good, useful, high quality, user-friendly, exciting, stimulating, cool, interesting,

[1] We also collected these measures after the introduction but before the COVID-19 misinformation clips [scale with all items ($\alpha = .60$, $M = 4.58$, $SD = 0.74$) vs. without reverse-coded items ($\alpha = .87$, $M = 5.07$, $SD = 1.15$)], and found that the results were very similar (to those obtained by analyzing the same measures administered after the COVID clips) in terms of statistical significance and valence of the extroversion manipulation effect.

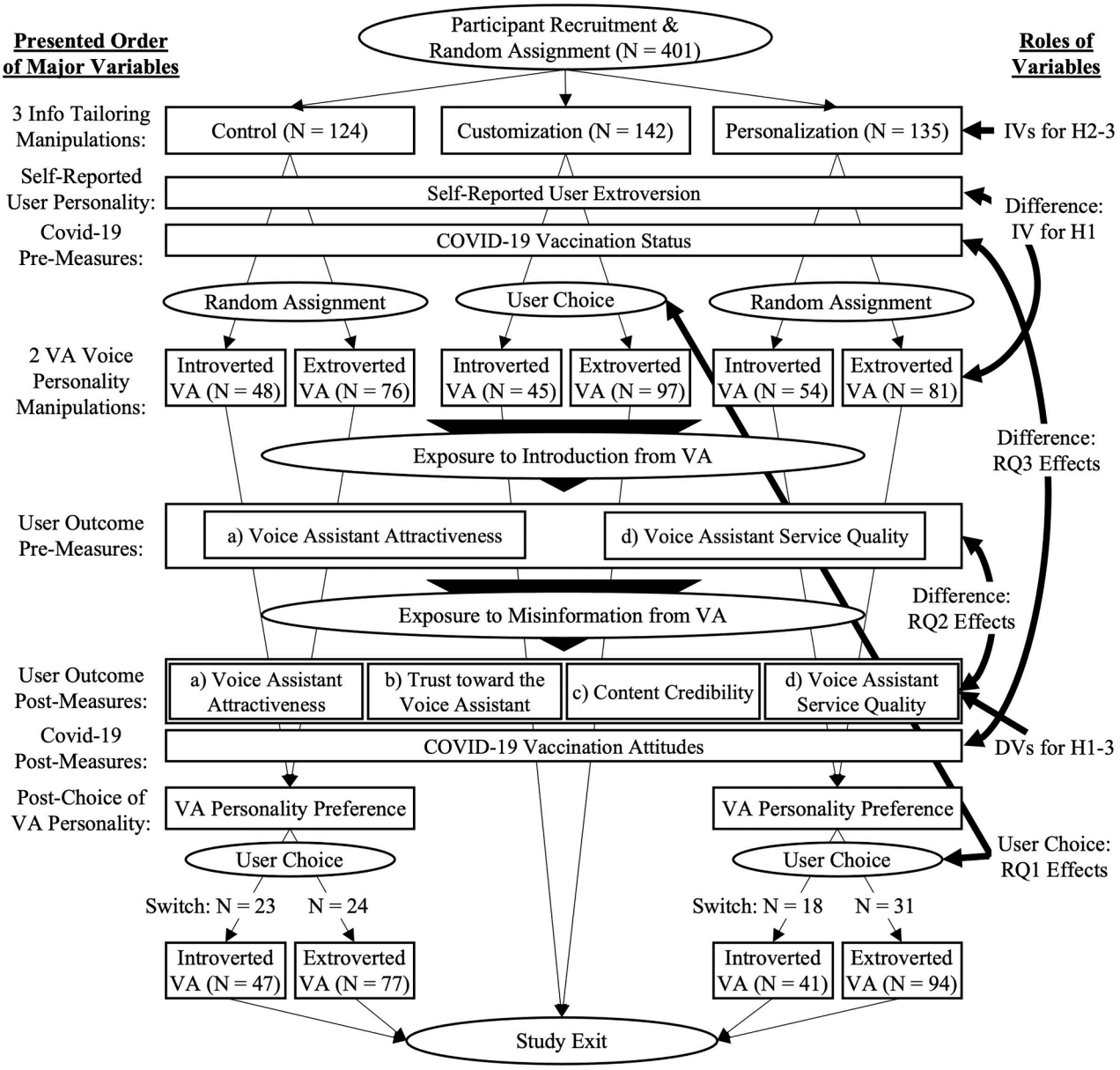

Fig. 3. Study Procedure.

Table 2
Voice Parameters of Manipulated VA Personality.

Amz Polly Voice (VA Name)	*VA personality*	*Volume*	*Rate*	Pitch from MATLAB	Pitch from Audacity
Ivy (Clementine)	*Extroverted*	*+20dB*	*115%*	*210 (adjusted −20 Hz)*	*224 (adjusted −20 Hz)*
Salli (Scarlett)	*Extroverted*	*+20dB*	*115%*	*194*	*200*
Joanna (Amber)	*Extroverted*	*+20dB*	*115%*	*158*	*192*
Kimberly (Violet)	*Introverted*	*−10dB*	*95%*	*176*	*189*
Kendra (Emerald)	*Introverted*	*−10dB*	*95%*	*157*	*156*

The adjustment of volume and speech rate of all VAs, as well as pitch level of Ivy was made in comparison to the original voice profile offered by Amazon Polly.

entertaining, and appealing. Similar to the attraction level, this measure was administered two times, i.e., before ($\alpha = 0.91$, $M = 5.53$, $SD = 0.93$) and after ($\alpha = 0.91$, $M = 5.53$, $SD = 0.93$) the COVID-19 Q&A.

3.3.4. User choices

For participants assigned to the customization condition, we saved data on which option users picked from among the 5 different VA voice profiles. For those in the control and personalization conditions, toward the end of the survey after the random assignment, users were asked to choose one voice out of five different profiles if given the chance.

3.3.5. COVID-related questions

We asked users' COVID-19 vaccination status. 73.1% had already gotten, or set up to get, the first or second shot(s) of the COVID-19 vaccine ($N = 293$). 19.0% were waiting until there are more studies to feel safe about getting one ($N = 76$). 6.2% said they would only get the vaccine in the future if they have to for practical or legal reasons such as job requirements ($N = 25$). 1.7% reported that they would not consider getting the COVID-19 vaccination at all ($N = 7$). Similar patterns

appeared for inclinations to get booster shots or newly developed vaccines, in that 70.1% responded affirmatively ($N = 281$), while 20.2% said they would wait ($N = 81$), 6.7% said they would only get the shot if required ($N = 27$), and 3.0% disfavored the idea ($N = 12$). 293 vaccinated individuals (among all 401 participants) said yes to getting a booster shot or newly developed vaccine in the future. We also measured changes in willingness to get the vaccination after interacting with the VA, for those who initially refused to get vaccinated. Among the unvaccinated 108 participants, 41 (38.0%) changed their mind into considering getting vaccinated after interacting with the VA. Considering that a substantial portion of the sample (over a third) of the unvaccinated changed their minds, we tested if those changes resulted from our similarity and information tailoring manipulations in the Results section.

3.3.6. Control variables

When we were running analyses on the perceptions of VA or content, we included previous experience with VAs ($M = 4.84$, $SD = 1.51$) as a covariate. Additionally, when investigating user perceptions after the COVID Q&A, individual differences in inherent user trust level and COVID-related fake news awareness were included as additional control variables. For the dispositional user trust, we used 4 items: e.g., "I trust people until they give me a reason not to trust them," "People are sincerely concerned about the problems of others" (McKnight et al., 2004; $\alpha = 0.84$, $M = 5.05$, $SD = 1.18$). For fake news awareness, we created an index out of 3 items measuring if the participants were aware (1 = never heard, 7 = fully aware) of any of the three COVID-19-related misinformation embedded in their VA's response: 1) about the risks of GBS applicable to all major vaccines, 2) about vaccination risks for children under 16 and pregnant/breastfeeding women, 3) about the inefficacy of COVID-19 vaccines against the Delta variant, and its decreased lethality and identifiability ($M = 5.02$, $SD = 1.18$). We also covaried the VA extroversion manipulation for regression models in our main analyses to test the effects of our major predictors such as VA-user personality similarity and personalization, independent of the randomly assigned VA personality.

4. Results

4.1. Manipulation check

The manipulation of VA's extroversion personality was found to be successful. Specifically, extroverted VA voices were rated higher in extroversion by the participants ($M = 4.57$, $SD = 0.67$), compared to the introverted voices ($M = 4.29$, $SD = 0.71$; $t(399) = 3.99$, $p < .001$).[2] When we checked the customization and personalization manipulations, participants in the customization condition were more likely to report that they were able to freely and specifically choose the VA they wanted ($M = 5.54$, $SE = 0.15$), compared to those in the control ($M = 4.94$, $SE = 0.16$, $p = .006$) and personalization ($M = 4.76$, $SE = 0.15$, $p < .001$) conditions, as intended. Users in the personalization condition were more likely to agree that the system automatically recommended them a VA tailored to their preferences ($M = 5.52$, $SE = 0.13$), than those assigned to the customization condition ($M = 4.88$, $SE = 0.13$, $p = .009$), while control condition did not statistically differ from the personalization condition ratings ($M = 5.37$, $SE = 0.14$, $p = .44$). In sum, the customization vs. personalization manipulations were successful. However, the control condition seemed to imbue a sense of system-driven algorithm being employed, similar to the personalization condition. Consistent with this pattern, all three conditions did not statistically differ in the extent to which participants felt the VA was chosen to meet their specific preferences and/or needs ($F(2, 398) = 0.14$, $p = .87$).

4.2. Similar VA-user extroversion/introversion personality effects

To test the effects of similar (vs. dissimilar) extroversion/introversion personality between the user and VA on a) VA attractiveness, b) trust toward the VA, c) content credibility, and d) VA service quality (*H1*), we ran regression models for each of the four dependent variables (DVs) separately, with the match (vs. mismatch) between the extroversion level of VA (manipulated) and user (self-reported) as the IV. Frequency of VA use, COVID-19 misinformation awareness, dispositional user trust, and randomly assigned VA's personality (i.e., extroversion vs. introversion) were included as control variables. We also included the information tailoring variable (dummy coded with control condition as a reference) in the regression model. This was to test the effect of personality similarity regardless of participants' assigned VA personality or the information tailoring condition.

Results suggested that the effect on similar (vs. dissimilar) voice personality between the user and the VA was significant on d) VA service quality ($b = 0.22$, $t = 2.47$, $p = .01$), but failed to reach significance on a) VA attractiveness ($b = 0.15$, $t = 1.83$, $p = .07$), b) trust toward the VA ($b = 0.15$, $t = 1.81$, $p = .07$), and c) content credibility ($b = 0.11$, $t = 1.45$, $p = .15$)[3] (see Table 3). The manipulated extroversion level of the VA had a stronger effect on all four DVs ($ps < 0.05$). Among the control variables, dispositional trust had significant positive association with all the four DVs ($ps < 0.001$), which suggested that those who tend to trust others by nature expressed more positive attitudes and higher levels of trust toward VAs as well. As a counterintuitive finding, individuals who reported that they were aware of the COVID-19 misinformation presented by the VAs tended to hold better attitudes and trust toward VAs ($ps < 0.001$). We further investigate the effects of COVID-related user perceptions and beliefs toward the end of the Results section.

In light of the significant main effects of the VA extroversion manipulation on user perceptions, we investigated if the similarity effect was contingent upon the randomly assigned VA personality. To do so, we added an interaction term between VA extroversion manipulation and the VA-user personality matching to the Table 3 regression models. Findings showed significant interaction effects on a) VA attractiveness ($b = 0.35$, $t = 2.07$, $p = .04$) and d) VA service quality ($b = 0.49$, $t = 2.73$, $p = .007$) but not b) trust toward VAs or c) content credibility ($ps > 0.14$).[4] More specifically, when the significant interactions were decomposed, the patterns suggested that similarity of personality mattered more when users were assigned a VA with an extroverted voice. In particular, when an extroverted VA was assigned, extroverted (compared to introverted) users tended to appreciate the VA more, whereas when an introverted VA was assigned, personality matching did not alter user attitudes (see Fig. 4).

4.3. Customization and personalization effects

Overall, we found no significant effects of either customization ($ps > 0.05$) or personalization ($ps > 0.50$) on a) VA attractiveness, b) trust toward the VA, c) content credibility, and d) VA service quality (see

[2] The perceived extroversion scale without the reverse-coded items was also rated higher for the extroverted VA voices ($M = 5.01$, $SD = 1.18$), compared to the introverted ones ($M = 4.74$, $SD = 1.37$; $t(399) = 2.12$, $p = .04$).

[3] When we applied the personality similarity categorization based on perceived users' extroversion scale without the reverse-coded items, the effect of similar (vs. dissimilar) voice personality on all DVs was not significant: a) VA attractiveness ($b = 0.10$, $t = 1.26$, $p = .21$), b) trust toward the VA ($b = 0.06$, $t = 0.74$, $p = .46$), c) content credibility ($b = 0.11$, $t = 1.28$, $p = .20$), and d) VA service quality ($b = 0.15$, $t = 1.71$, $p = .09$).

[4] The interaction effects using similarity categorization without the reverse-coded user personality items were significant on all outcome variables: a) VA attractiveness ($b = 1.17$, $t = 6.17$, $p < .001$), b) trust toward VAs ($b = 0.91$, $t = 4.77$, $p < .001$), c) content credibility ($b = 0.97$, $t = 4.78$, $p < .001$), d) VA service quality ($b = 1.30$, $t = 6.41$, $p < .001$).

Table 3
Regression Models for All Dependent Variables.

	a) VA Attractiveness			b) Trust Toward the VA			c) Content Credibility			d) VA Service Quality		
	b	*T*	*p*	*b*	*t*	*p*	*b*	*t*	*p*	*b*	*t*	*p*
Intercept	1.97	8.02	0.00	2.86	11.9	0.00	2.94	11.5	0.00	1.76	6.69	0.00
Prior VA Use	0.03	1.10	0.27	0.02	0.77	0.44	0.02	0.63	0.53	0.05	1.81	0.07
Dispositional User Trust	0.27	7.24	0.00	0.22	6.01	0.00	0.26	6.67	0.00	0.25	6.16	0.00
COVID Misinfo Awareness	0.32	8.24	0.00	0.24	6.50	0.00	0.20	4.93	0.00	0.36	8.79	0.00
Customization (vs. control)	0.14	1.41	0.16	0.02	0.23	0.82	0.04	0.42	0.67	0.21	1.93	0.05
Personalization (vs. control)	0.07	0.68	0.50	0.03	0.28	0.78	0.07	0.63	0.53	0.02	0.14	0.89
VA Extroversion (vs. Introversion)	0.20	2.38	0.02	0.18	2.23	0.03	0.17	1.95	0.05	0.19	2.11	0.04
Personality Similarity (vs. Dissimilarity)	0.15	1.83	0.07	0.15	1.81	0.07	0.12	1.45	0.15	0.22	2.47	0.01

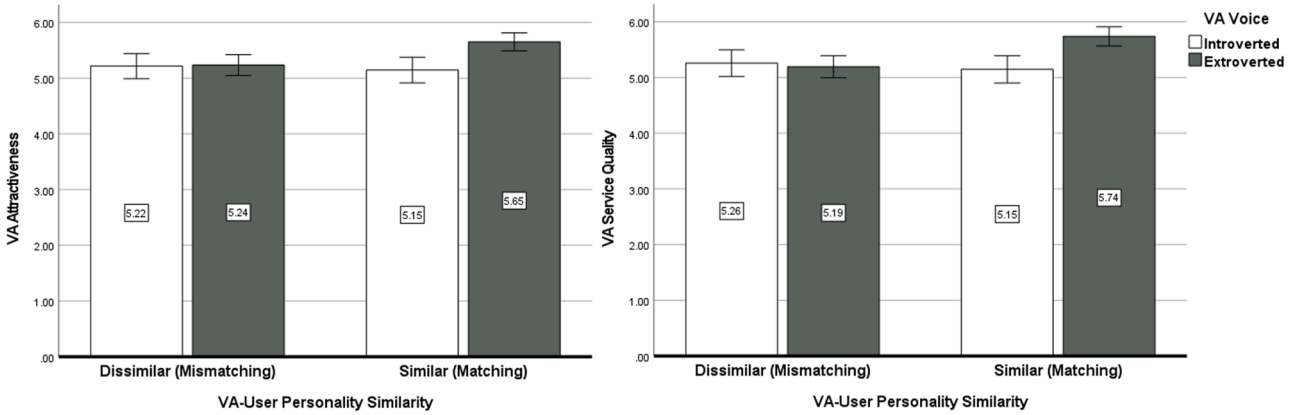

Fig. 4. The Effects of VA-User Personality Similarity on VA Attractiveness (left) and VA Service Quality (right).

Table 3). Therefore, H2 and H3 were not supported by our data.

4.4. User choices

Related to *RQ1*, when we only selected cases of users assigned to the customization condition, users' VA personality choice (i.e., extroverted vs. introverted) was not influenced by their own self-reported extroversion personality (Exp(b) = 1.12, p = .68).[5] We also note that users in the customization condition did not prefer a particular personality, compared to the conditions where the VA personality was randomly assigned ($\chi^2 = 2.38, p = .30$). On the other hand, when participants were not allowed to customize (assigned to the control or personalization conditions), they tended to switch out of the voice assigned to their VA ($\chi^2 = 10.99$, $p < .001$). Specifically, among the 102 assigned to an introverted voice, about half switched to choosing an extroverted voice later on (N = 55, 53.9%). For the 157 assigned to the extroverted voice, only 41 (26.1%) switched their choice to the introverted voice, whereas the majority of 116 users retained the extroverted voice. More specifically, in the control condition, 24 users switched to extroverted from introverted voice out of 48 (50.0%), while 23 users switched to introverted from extroverted voice out of 76 (30.26%). In the personalization condition, 31 users switched to extroverted VA out of 54 (57.4%), whereas 18 to introverted out of 81 (22.2%).

4.5. COVID-related content effects

To test if the introduction of COVID-related misinformation was causing changes in how users perceived VAs (*RQ2*), we ran repeated measures analyses with 1) extroversion personality similarity (i.e., similar vs. dissimilar VA-user personality) and 2) information tailoring (i.e., control vs. customization vs. personalization) as between-subjects variables, on pre- and post-measures of a) VA attractiveness and d) VA service quality, with control variables included. Findings suggested that there was no change in either outcome after hearing misinformation from the VA ($ps > 0.69$), and these effects were not significantly altered by 1) personality similarity and 2) information tailoring conditions ($ps > 0.51$).[6]

We also examined if the changes in COVID vaccination stance differed as a function of the major IVs (*RQ3*). Among the 108 unvaccinated individuals, a slightly higher number of individuals were assigned to the mismatched personality condition (N = 58, 53.7%). In terms of information tailoring conditions, 39 (36.1%) were assigned to the customization condition, 36 (33.3%) to the personalization condition, and 33 (30.6%) to the control condition. As many as 41 (38.0%) of those 108 unvaccinated individuals changed their mind to get vaccinated after their interaction with the VA, with the higher proportion coming from the personality matched condition (N = 25, 50.0% of the unvaxxed assigned to this condition changed their mind into getting vaccinated) than the mismatched condition (N = 16, 27.6%),[7] and customization condition (N = 19, 48.7% of the unvaxxed assigned to this condition shifted toward getting vaccinated), compared to the control (N = 10, 30.3%) and personalization (N = 12, 33.3%) conditions. Statistically speaking, when the change in willingness to get vaccination was

[5] When we used the variable of users' self-reported extroversion personality only consisting of non-reverse-coded items, the effect was also non-significant (Exp(b) = .77, p = .12).

[6] Similar to the main analyses, when we included the personality similarity categorization variable without the reverse-coded user personality items in the statistical model, there were no changes in attractiveness and attitudes toward VAs after hearing the COVID misinformation ($ps > .73$), nor any changes deriving from differences in 1) personality similarity and 2) information tailoring conditions ($ps > .62$).

[7] When we categorized personality similarity conditions based on only non-reversed user personality items, 24 were assigned to personality-matched, compared to 17 to the mismatched, VA-user condition.

Table 4
Correlations among COVID-related Beliefs and Concerns and COVID Misinformation Awareness.

		2	3	4	5
1	COVID misinformation awareness	.31***	.45***	.29***	.34***
2	Belief in the effectiveness of major COVID vaccines		.04	−0.24***	.39***
3	Concerns about the long-term side effects from vaccines			.40***	.13**
4	Disbelief in the effectiveness of major COVID vaccines				−0.06
5	Concerns about the COVID pandemic returning				

included as a DV in a logistic regression model with all the control variables included, personality matching (vs. mismatching; Exp(b) = 2.79, p = .02) significantly increased the possibility to change the unvaccinated users' mind to get vaccinated. Although the higher number of unvaxxed users who decided to get vaccinated came from the customization condition, the customization effects on vaccination willingness failed to reach statistical significance (Exp(b) = 2.57, p = .08), nor was there a significant personalization effect (vs. control; Exp(b) = 1.21, p = .73).

We note that users' self-reported awareness of the COVID-19 misinformation was positively correlated with all of the COVID-related beliefs and concerns regardless of the valence (ps < 0.001), while belief in the effectiveness of the vaccine was not correlated with concerns about the long-term side effects, and the disbelief in vaccine effectiveness was not associated with concerns of the COVID pandemic returning (see Table 4). COVID fake news awareness seemed to reflect stronger user interest and attention (in the form of beliefs and concerns) than the positive or negative stance toward the COVID-related topic.

4.6. Exploratory analysis with perceived homophily of VA

While we operationalized personality similarity by manipulating the VA extroversion/introversion and matching it with the extroversion/introversion state of users, one may argue that this operationalization may have not been sufficient enough to evoke the feeling among users that the VA was similar to them. Thus, as an alternative measure of similarity between the user and VA, we measured perceived homophily,[8] and tested its effects by replacing the original similar (vs. dissimilar) extroversion/introversion personality variable in Table 3. The purpose was to capture the perceptual effect that may sometimes be sufficient to induce attraction among individuals (Infante et al., 1997). We were also cognizant of the possibility that "perceptual" similarity can have different meanings to users compared to the "assigned" similarity of personality based on users' self-reported extroversion level.

Perceived homophily predicted increase in all the four DVs (ps < 0.001), with the VA extroversion manipulation also showing a significant positive main effect on all DVs (ps < 0.05; as reported in the earlier models with personality similarity included, instead of perceived homophily). In other words, the more similar participants thought the VA was to them, the more they felt the VA to be attractive and trustworthy. A correlation analysis revealed that the difference between the assigned personality matching was not correlated with the perceived homophily of the VA (r = 0.05, p = .28), which means the effects of "assigned" and "perceived" personality similarity between the VA and the user manifested independent of each other, despite sharing similar patterns in affecting some outcome variables.

Paying attention to this strong perceptual effect, and the generally non-significant information tailoring effects, we further examined if the customization or personalization effects were contingent upon how similar the VA was perceived to users. To do so, we created and added interaction terms using the (dummy-coded) customization and personalization variables and perceived homophily of the VA to the above regression model. This exploratory analysis yielded two significant interaction effects between customization (vs. control) and perceived homophily on (b) VA trust (b = 0.24, t = 2.71, p = .007) and (c) content credibility (b = 0.20, t = 2.03, p = .04), but not on the other two DVs (ps > 0.13). Personalization (vs. control) generally did not moderate the homophily effect on any of the user perceptions (ps > 0.43).[9] When the significant interaction effects were decomposed, the positive homophily effect on trust perceptions were more pronounced for participants who were given the chance to customize their VA voice (see Fig. 5). This was the case, even when the participants assigned to the customization condition did not tend to pick a VA personality closer to themselves, in that the selection of extroverted (vs. introverted) VAs was not affected by the self-reported user extroversion level (Exp(b) = 1.12, p = .68). Regardless of whether they exercised their choice or not, participants who were given the chance to customize their VA voice showed a stronger positive connection between perceived homophily (similarity) of the VA and trust toward VA as well as its content compared to participants who were not offered the opportunity to customize their VA voice. Put another way, lack of perceived homophily was more strongly related to distrust of VA in the customization condition compared to the other two conditions.

5. Discussion

5.1. Summary of findings

First, we found that manipulated personality similarity (compared to dissimilarity) resulted in higher levels of attraction toward the VA and more positive service evaluation, but only when the user was assigned an extroverted VA. In general, participants showed a general preference for extroverted over introverted VAs. Those who were not able to customize and those assigned an introverted VA voice expressed a stronger desire to change their VA personality into one with an extroverted voice. Regardless of how similar the assigned VA extroversion personality was to the user, perceived homophily of the VA was positively associated with all the outcome variables. This was particularly evident when participants were offered the option of customizing their VA. Interestingly, the delivery of COVID-related misinformation by the VA did not reduce its attraction level. However, personality similarity seemed to trigger resistance to misinformation messaging, evidenced by unvaccinated participants changing their mind into getting vaccinated as a result of their interaction with the VA.

5.2. Effects of VA-user personality similarity

Our findings suggest that perceived similarity cannot be fully captured through procedural matching of extroversion/introversion personality for self vs. VA. Closeness in users' self-rated vs. VAs'

[8] To measure, we used 4 items from a perceived homophily scale intended for interpersonal communication (McCroskey et al., 1975) based on a 7-point semantic scale: i.e., "She was unlike vs. like me," "She was different from vs. similar to me," "She does not think vs. thinks like me," "She does not behave vs. behaves like me. (α = .82, M = 5.41, SD = 1.12).

[9] As part of our exploratory analyses, we also tested the interaction effects between information tailoring and the original extroversion personality similarity variable. However, no significant effects appeared for either customization (ps > .11) or personalization (ps > .23) on any of the 4 outcome variables.

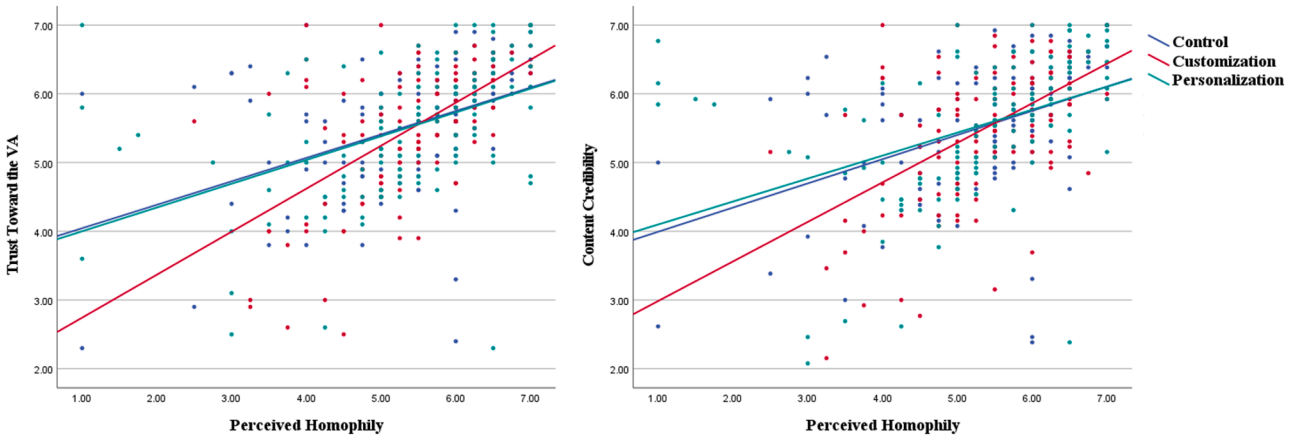

Fig. 5. Effects of perceived homophily on trust toward the VA and content credibility by information tailoring.

manipulated personalities predicted a significant increase in perceived attraction and attitudes, but only for extroverted VAs. There was a stronger and general preference for extroverted over introverted VA voices, which replicates previous findings (Chang et al., 2018). Extroverts' attitudes significantly improved when VA personality matched, but introverts did not show the same matching effect. This finding may have resulted from positive violation of expectations due to the abundance of introverted VAs available for commercial devices (for our manipulation, we found in our pretests that the volume and speed adjustments to the original Amazon Polly voices needed to be greater for extroverted, compared to introverted, versions). It could also be indicative of extroverts' social experience of the VAs resulting in higher importance of matched personalities for them compared to introverts.

As an alternative measure to VA-user similarity, perceived homophily of the VA had stronger association with all the outcome variables, regardless of the manipulated personality matching of extroversion between the user and VA. This finding not only adds empirical evidence to the similarity attraction effect (Byrne, 1971) being applicable to interaction with virtual beings (Nass and Lee, 2000, 2001), but also points to the importance of "perception" of tailoring over "procedure" to foster feelings of similarity with the VA and create a positive social user experience. Overall, the similarity effects offer practical advice to designers in considering individual differences to offer more attractive (similar) voices to extroverted users, and in essence, to seek designs that trigger similarity perceptions to create a better social user experience with VAs.

5.3. Customization vs. personalization effects and user choices

Perceived homophily played an important role in amplifying the customization effects on user perceptions. Even when users who customized were not more inclined to choose a VA similar to themselves, the perceived homophily of the VA was more strongly associated with the increase in user trust and content credibility, compared to those in the other information conditions. The key contributing factor for the positive effects of customization on credibility perceptions is its positive homophily effect, an exploratory yet important theoretical contribution of the present study.

Regardless of the choice users made in terms of the VA voice personality (which was not necessarily similar to them), once the users heard misinformation from the VA, they seemed to support VA's credibility when the VA felt similar to them, whereas distanced themselves from the VA's message when the VA felt dissimilar to them. That is, customization seemed to alter credibility perceptions based on users' self-association with the VA. This speaks to the persuasive potential of VAs. When the VA is customized, it is seen as being one with the user, which increases sense of identity (i.e., reflection of self), as predicted by the agency model of customization (Sundar, 2008a), and therefore enhances credibility perceptions by cueing a sense of own-ness (Sundar, 2008b). This also reflects our natural affiliative tendency toward our interactants, be they other humans or virtual beings, as predicted by CASA (Reeves and Nass, 1996).

Personalization, on the other hand, exerted minimal effects on the outcome variables. This was the case even when our manipulations induced significant differences in customization vs. personalization perceptions. Users in the personalization condition more frequently reported that the system automatically recommended them a VA tailored to their preferences than those assigned to the customization condition. However, as demonstrated by the exploratory analysis in the results section, the above homophily effect seen among customizing users was significantly lower among those in the personalization as well as control conditions (see Fig. 5). It seems that personalization was imbuing users an impression similar to the control condition, as indicated by the manipulation-check results. That is, participants in the control condition assumed that the VA was matched to their self-reported extroversion personality even though this was not explicitly stated or, for that matter, offered in reality. It seems that to modern-day users, personalization is assumed as a default, which makes it an expected gratification sought from smart speakers, as documented by Sundar et al. (2019).

In terms of user behaviors in voice personality selection, those who were given a chance to customize did not always choose a VA with a similar personality, even though perceived homophily was positively associated with all outcomes. Those who were not able to customize wanted to change their VA personality later on, but only when they were assigned an introverted VA. There seems to be an underlying desire for extroverted VAs in a one-voice-fits-all model, even though users do not tend to choose extroverted (over introverted) ones when given a chance.

5.4. COVID-related content effects

One major finding pertains to changes in COVID-related attitudes after exposure to misinformation from the VA. Personality similarity influenced unvaccinated individuals to get vaccinated. This was rather counterintuitive in that similarity triggered unvaccinated individuals to counter the fake news (which confirms their concerns over vaccination). Considering the generally positive effects of personality similarity on user outcomes, we would expect the unvaxxed to be even more opposed to vaccination. But the reverse was true—they became pro-vaccination. This shows how homophily can increase individuals' concerns toward persuasive messaging from smart speakers and VAs. Similarity of VA voice appears to make users process the information more carefully, critically and systematically, making users reassess previous beliefs. And, considering that control and personalization (vs. customization) conditions showed similar personalization perceptions on manipulation-

check items, personality similarity manipulation may have been perceived as automated (vs. customized). Specific to the COVID-19 misinformation context, it relates to Sharevski et al.'s (2022) findings of how vaccine-hesitant VA users expressed higher perceived accuracy of the incorrectly rephrased COVID-19 information (via a malicious Alexa skill), compared to pro-vaxxers. This has theoretical implications for literature in resistance toward persuasive messages, which points to the persuasive power of personality matching in the relatively new context of voice-driven technologies. When applied to the contexts of public health and social good, our findings have practical value of utilizing personality matching in VAs to enhance public awareness of positive health messages and promote various health-related interventions.

5.5. Limitations and future directions

While our study offers theoretical and practical implications as mentioned above, a few limitations merit attention so that they can inform future research. First of all, the current work did not allow for interactive engagement with the voice clips, but instead relied on pre-recorded and static audio clips. For instance, if this study had followed Cho et al.'s (2020) customization manipulations via real-life interactions between the user and VA utilizing an Alexa skill, it could have probably shown more pronounced effects on user trust and content credibility after exposure to controversial health information. In addition, our use of COVID-19 misinformation may lack ecological validity, considering that fake news spread is not yet prevalent in VAs, compared to social media. As an attempt to bridge social media's impact in fake news dissemination with VAs as another potential medium, Sharevski and Gover (2021) studied how Alexa verbally relaying Tweets including Covid-19 misinformation with warning cues can affect perceived accuracy of fake news, although vaccine-hesitant Alexa users ignored those warning signs. As such, there is room for future studies to incorporate other media channels (e.g., social media) and compare the contextual effects of various topics (e.g., COVID-19 misinformation vs. controversial facts related to general health) and content (e.g., fake news vs. factual information) coming from customizable smart speakers with personality matching services. Furthermore, our personalization condition did not actually offer tailored VA personality, which may have contributed to the similarity in perceived tailoring between the control and personalization conditions. This may be why Hoegen et al.'s (2019) automated manipulation of personalized conversational style rendered positive matching effects, in contrast to the null findings with our personalization manipulation. Thus, a more rigorous operationalization and conceptual comparison of different information tailoring services offered by smart speakers should be attempted in the future. Just as how the illusionary manipulation may not be an accurate reflection of automated personalization, all of our outcome variables relied on self-reported measures instead of actual user behavioral data, which may not reflect actual user perceptions, attitudes or behaviors. We also merged self-reported items from different metrics to represent some outcome variables. While we made these decisions based on internal reliability analyses, we acknowledge that this calls for testing of other outcome metrics as well as further replication and validation of the consolidated self-reported measures we used from different sources. Finally, our core findings support stronger effects of perceptual similarity over automated extraversion matching, which resonates with Völkel et al.'s (2020) analyses (of user survey data and online reviews) which found that commonly applied human personality dimensions (such as Big Five) on VAs are not sufficient to define VA personalities. In fact, relating to our less pronounced effects of manipulated extroversion vs. introversion manipulation via voice attributes, the attempt from Völkel et al. (2022) to manipulate an introverted (vs. neutral) chatbot based on text-centric verbal cues failed to achieve successful manipulation. As a result, this leaves our fundamental question of which kinds of specific vocal and/or verbal attributes make VAs feel similar, thus attractive to users, unanswered and left open for the future studies to address.

6. Conclusion

Our study suggests that similarity attraction persists in HCI for voice interaction with smart speakers. In particular, the similarity "perception" (vs. automatic matching of similar personality) was found to be key in predicting user attraction and trust by enhancing their social experience with the VAs. Customization also mattered in strengthening this positive effect, when users expressed higher homophily with the VA. But if customization of the voice personality is not feasible, an extroverted voice seems ideal for VAs operating on the one-voice-fits-all principle. In light of our unique context (i.e., COVID-19 misinformation delivery), one noteworthy finding comes from the power of personality similarity in changing minds of the unvaccinated into getting vaccinated, ironically triggering users to resist misinformation regarding the efficacy of vaccination. It seems that the self-association with the VA can lead users into more deliberate processing, and even counter-arguing, of information when they encounter strong advocacy messaging.

CRediT authorship contribution statement

Eugene C. Snyder: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Writing – original draft, Visualization, Project administration. **Sanjana Mendu:** Conceptualization, Methodology, Software, Validation, Investigation, Writing – original draft, Visualization. **S. Shyam Sundar:** Conceptualization, Methodology, Validation, Writing – review & editing, Supervision. **Saeed Abdullah:** Conceptualization, Methodology, Writing – review & editing, Supervision.

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.

Data availability

Data will be made available on request.

A. Appendices

A.1. Transparency documentation for changes made after preregistration

There were five major changes made to this paper in terms of method and analyses from our preregistered proposal prior to data collection:

1. **Reframing of some hypotheses, research questions, and title**

The main effects of personality similarity (H2 in preregistration, H1 in this manuscript), customization (H1 in preregistration, H2 in this manuscript) and personalization (RQ1 in preregistration, H3 in this manuscript) were examined as initially proposed in the preregistration, with different order of presentation and minor labeling changes of variables to enhance the readability and interpretation of this study.

RQ2 in preregistration was designed to examine the mediating roles of i) sense of identity, ii) sense of control, iii) perceived similarity, iv) social presence, and v) perceived relevance in the effects of 1) customization, 2) personalization, and 3) personality similarity (previously labeled as 'matching personality'). Majority of the mediating effects were found to be non-significant, and after reviewer feedback on redundant content, was excluded in this manuscript. The few interaction

effects that were significant are reported as part of exploratory analysis, as a way to streamline and add clarity to the presentation of our findings.

The research questions exploring the disparate effects of (*RQ3*), and the interaction effects among (*RQ4*), the 1) customization, 2) personalization, and 3) matching personality variables were naturally resolved as we offered findings in correspondence to their main effects (*H1–3*), thus, were not stated as separate, independent research questions. *RQ5* (in preregistration, *RQ1* in this manuscript) focused on the user choices and their effects seen among participants who did not customize, was expanded into a research question studying not only the users' desires to change their assigned voice assistant personality, but also the user choices among those who were given a chance to customize the voice of their virtual assistants.

Due to the aforementioned reframing of the hypotheses and research questions, RQ6–7 from the preregistration were folded into RQ2–3 in this manuscript. While remaining similar in terms of content (i.e., the nature of inquiries, and answers they seek), some COVID-related variables showing mainly non-significant effects were excluded and simplified for clarity. We also edited the title of this study to better reflect the findings gleaned from the data.

2. Data collection

Due to challenges faced with the manipulation of the voice personality of the virtual assistants, the data collection was postponed to August 2021 from the original proposed timeline of April/May 2021. We also utilized MTurk instead of Cloud Research which had a lower processing fee for the type of research we were conducting at the time.

3. Added voice personality manipulation of voice assistants

Initially, we proposed to create 4 different voice profiles of voice assistants, which varied by personality (i.e., 2 extroverted and 2 introverted female voices). After going through pretests to ensure voice manipulation of the virtual assistant, we arrived at 5 voice profiles (i.e., 3 extroverted and 2 introverted female voices) instead of 4, to fully utilize all the female voice options offered by Amazon Polly (which we adopted for our study).

While we were re-examining the design of our personality similarity manipulation, we realized that the similar (vs. dissimilar) personality defined by us would not necessarily make users feel that the assigned voice assistant is more similar to them. As such, we added self-reported items in our survey to directly measure perceived similarity (in the form of homophily) as an alternative measure to similarity in personality between the user and voice assistant. Since the measures overlapped with the concept of "perceived similarity" that were initially proposed as a potential mediator, we did not consider perceived similarity as a mediator variable. Furthermore, all analyses involving "perceived homophily" were labeled as exploratory.

4. Change in COVID-scripts and added measures

By the time we finalized our personality manipulation of the voice assistants and were ready to collect data, the original COVID-related misinformation scripts we proposed in the pre-registration became obsolete. Thus, we replaced and modified the scripts to reflect misinformation that were related to the most recent COVID news, especially the increasing concerns over the Delta variant, at the time of data collection. We also added some measures related to COVID-related beliefs and attitudes to better understand user perceptions in the context of COVID misinformation delivery from voice assistants. Findings from those measures are reported in our manuscript.

5. The use of control variables

Among all the potential control variables we measured, we controlled for previous experience with voice assistants, dispositional user trust, and extroversion/introversion manipulation of the voice personality of the voice assistants, which can directly affect user outcomes related to attraction and trust toward voice assistants theoretically. To this list, we added awareness of presented misinformation measures to control for in the main analyses, to make sure we capture the similarity and information tailoring effects regardless of users' knowledge of the fake news. Basic demographic information of the participants (e.g., age, gender, ethnicity) was included in the manuscript.

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