Confusion and Information Triggered by Photos in Persona Profiles

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ABSTRACT

We investigate whether additional photos beyond a single headshot can increase the degree of information provided by persona profiles without the negative effects of confusion. We conduct an eye-tracking experiment and qualitative interviews with digital content creators after varying in the persona photos via a single headshot, a headshot, and photo of the persona in different contexts, and a headshot with photos of different people possessing the key persona attributes of gender and age. Findings show that contextual photos provide significantly greater information to the end users concerning the persona; however, showing photos of multiple people engenders confusion and lowers informativeness. Also, additional photos have the expected effect of requiring more cognitive focus, as measured by eye tracking metrics, and these metrics are correlated with levels of informativeness and confusion. Furthermore, various interpretations of the persona based on the choice of photos are biased by the end users' experiences and preconceptions. Concerning persona design, findings indicate that persona creators design power in selecting photos and the choice of photos when producing persona profiles needs to aligned photos with the intended objectives of the persona use. The addition of contextual photos can additional informativeness but comes at the cost of additional cognitive focus by the end users. Adding contextual photos increases the perceived informativeness of the persona profile with no increase in perceived confusion, but photos of different people evoke confusion about the targeted persona.

Author Keywords

personas; user perceptions; online data representations

1. INTRODUCTION

A persona is a fictional person representing a user segment and usually presented in a one or two-page persona profile (Nielsen, 2013). Although personas have been integrated in the software design process, computer science and other fields (Cooper, 2004) for some years (Cooper, 1999), it is difficult to decide how to best create persona profiles (Grudin & Pruitt, 2002; Hill et al., 2017; Marsden & Haag, 2016; Pruitt & Adlin, 2006) as one must decide what information to include and what to exclude (Oulasvirta et al., 2017). However, there has been little rigorous research into the design of persona profiles, especially concerning the use of photos within these profiles. Over the years, a *de facto* layout of the persona profile has been developed (Nielsen, Hansen, Stage, & Billestrup, 2015) that includes a one to two-page description with a photo, most often a headshot

of a person representing the user segment, as shown in Figure 1Figure 1. A typical persona profile layout with notes denoting sections included; modified from (Righi & James, 2007)..

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Yet, there exists "no rigorous or even rational basis for the selection of details to attribute to the persona." (Voil, 2010, p. 3). However, persona creators have the critical need to understand the design implications of diverse information content on the perceptions of personas the end users. This understanding is required so that the development of persona profiles may be accurately designed and improved. Unfortunately, there have been limited studies that systematically examined different profile layout options. In this research, we partially address this shortcoming by experimentally researching three persona layouts with the objective of determining which layouts are the more optimal.

Specifically, the consequence of the photos has not been commonly researched, and to our knowledge, no prior work has examined the effects and potential issues the photo might pose when shown to end users, especially in design teams and workgroups with an international, interdisciplinary, and/or cross-cultural set of members. A persona photo generally depicts a specific gender, nationality, ethnicity, occupation, race, etc. that can be difficult to align with a culturally diverse pool of end

users of that persona (Nielsen & Hansen, 2014). Though one photo has the advantage of, perhaps, not introducing non-relevant attributes, a single photo can also open the door for biases concerning the interpretation of the persona (Pröbster, Haque, & Marsden, 2018), and a single photo may convey cultural assumptions, causing end users to associate stereotypical attributes to the person in the photo (G. Viana & J. Robert, 2016).

In this research, we specifically investigate this tension using an approach to persona profiles that include multiple photos for a single persona in two different presentation layouts: (a) contextual: additional photos of the same person in different contextual situations, in this case, the persona seen in work and leisure situations; and (b) attribute-similar: additional photos of different but similar people but all with the persona's properties that are particularly noticeable in photos, such as gender, ethnicity, and approximate age. As the underlying data was based on age and gender only, we altered the ethnicity of the photo as the non-relevant aspect of the personas. We compare and contrast these two layouts with an identical persona having only one headshot photo, as the baseline, via a controlled laboratory eye tracking study along with in-depth interviews in the workplace of online content creators whose job goals include reaching a global audience. Our findings show that end users' visual interactions with the persona profiles do significantly increase with contextual and attribute-similar photos, relative to only using a headshot photo. In addition, contextual photos significantly improve the information end users receive from a persona profile; however, showing photos of different but similar individuals creates confusion and lowers the informativeness perceived by the participants.

This research is impactful given that persona profiles are typically the chief end product in the persona development process. Given that personas have claimed benefits (Adlin & Pruitt, 2010; Beyer & Holtzblatt, 1998; Dharwada, Greenstein, Gramopadhye, & Davis, 2007; Drego & Dorsey, 2010; Eriksson, Artman, & Swartling, 2013; Friess, 2012; Goodwin & Cooper, 2009; Guðjónsdóttir & Lindquist, 2008; Judge, Matthews, & Whittaker, 2012; Massanari, 2010; Miaskiewicz, Grant, & Kozar, 2009; Pruitt & Grudin, 2003; Rönkkö, 2005), it is important that we seek to improve the design process, as the procedure of creating personas is reportedly costly, difficult, and lengthy (Drego & Dorsey, 2010; Flaherty, 2018; Nielsen & Hansen, 2014; G. Viana & J.-M. Robert, 2016). Given this cost, it is critical to get the end product of the persona profile as optimal as possible. Optimal design will further increase the applicability and usefulness of personas in real decision-making circumstances by the organizations that rely on personas as a source of audience, user, or customer insights.

We are specifically interested in the effect of photos on the interactions with the persona profiles by end users as part of an on-going research project aiming to automate the creation of persona profiles (An, Kwak, Salminen, Jung, & Jansen, 2018a, 2018b;

Salminen et al., 2017). Determining the optimal content, layout, and photo of generating personas automatically from online data (An et al., 2018a; Jung et al., 2017) is quite valuable because it is relatively easy to manipulate persona profile elements and arrangement according to particular users' real-time needs or preferences. Prior work has shown how personas can be generated automatically from social media data by retrieving content interaction metrics for demographic groups via application programming interfaces (APIs) and processing them via computation techniques (e.g., non-negative matrix factorization) (Jung et al., 2017; Miaskiewicz, Sumner, & Kozar, 2008). With the decrease in the amount of textual information with such automatically generated personas, photos become potentially even more important within the persona profile, which is common also with ad-hoc and prototypical personas (Norman, 2006; Gothelf, 2012). Given this, an understanding of the design of persona profiles is essential.

In this research, we propose better persona profiles in terms of more informativeness and of less confusion via findings of a user study, with initial results reported in (Salminen et al., 2018). These research results can have an impact on enlightening data-driven persona generation, while also informing the design of persona profiles that use traditional creation approaches.

2. REVIEW OF LITERATURE

The subsequent subsections review important prior works concerning persona content, implications for use in cross-cultural teamwork, and for automatic generation of persona profiles.

a. Prior work on persona content

Nearly all persona descriptions include a persona photo. While some studies report the photo is given limited attention by end users (Hill et al., 2017; Pröbster, Haque, Haag, & Marsden, 2017), this is at odds with findings from other domains (Hum et al., 2011; Rainie, Brenner, & Purcell, 2012; Reiners & Alexander, 2013; Wu, Chang, & Yuan, 2015) that show photos receive a significant amount of focus. Most researcher on personas present the photo as an integral and necessary part of the persona profile (Grudin, 2006), relying on automatic processes of person recognition (Banaji, Bhaskar, & Brownstein, 2015; Bargh, 2014; Higgins, 1996), although such processes may be prone to biases (Banaji & Hardin, 1996; Fiske, 2000).

It has been noted that there is a lack of studies concerning the use of images in persona (Nieters, Ivaturi, & Ahmed, 2007). The textual content of persona profiles has been studied by a few researchers (Floyd, Jones, & Twidale, 2008; Junior & Filgueiras, 2005; Nielsen et al., 2015). These prior studies present persona profiles that include textual information from the following categories: (a) background information, such as name, age, gender, education, etc.; (b) design-related information, such as usage or behaviors; and/or (c) business- and marketing-related information, such as buying preferences. These prior studies have examined only the textual information and have not investigated the accompanying profile photo. Two prior works have

surveyed if illustrations make personas memorable (Long, 2009; Nieters et al., 2007), with conflicting conclusions concerning if drawings are better than photos.

There has also been some research indicating that images have the effect of making personas memorable. Nieters, Ivaturi, and Ahmed (2007) noted that context images where the person was performing some action made the persona not only more memorable, but they instilled greater confidence in the persona content and users could empathize with the person in the photo. The researchers concluded that these photos increased the fun and the stickiness of personas (Nieters et al., 2007). Other research (Siarohin et al., 2017) reports that certain image attributes can make the image more memorable, although the researchers focus on filters rather than the people. To the best of our knowledge, only one prior work has examined whether additional photos are better than one (Hill et al., 2017); this study focused on gender stereotyping by the end users. The study reported that additional photos did not affect end user stereotyping, although the researchers report there was little stereotyping occurring. However, Jensen et al. (2017) report that whereas photos enable identification, engender empathy, and support recall of personas, photos also seem to provoke both ethnicity and gender stereotypes. Thus, limited prior work has examined the presence of the persona profile's information and even less research has examined the impact of photo selection on the end users' understanding of personas.

b. Prior work on persona content

In work from non-persona domains, researchers have investigated the effect of photos on trust. In an experiment of website images in the commercial area, photos were shown to have no significant effect on the trustworthiness of companies, although the presence of photos resulted in an increase in the perceived trustworthiness of poorly performing companies but a decrease for companies with a good reputation (Riegelsberger, Sasse, & McCarthy, 2003). However, in a similar study (Bente, Baptist, & Leuschner, 2012), trustworthy photos were shown to increase the positive reputation and were correlated with higher purchase rates. However, no photo led to distrust for companies with no reputation, suggest that pictures, especially positive ones, increase trust via a reduction in uncertainty (Bente et al., 2012).

From the field of advertising, images of attractive models have been shown to have a positive effect on viewer reaction (Baker & Gilbert A. Churchill, 1977), although this reaction is moderated by the perceived attractiveness and gender of the end user (Sim, Saperia, Brown, & Bernieri, 2015). Concerning end user engagement, using 1 million Instagram images, research shows that photos with faces are 38% more likely to receive likes and 32% more likely to receive comments regardless of the number of faces, age, or gender (Bakhshi, Shamma, & Gilbert, 2014). Comparing the effect of images on end user support for military campaigns, research reports that different contextual photos have an effect on campaign support (Bauer & Carpinella, 2018).

Primary in the image area has noted how quickly people can recognize faces and even recall faces from memory (Bruce & Young, 1998). Investigating the effect of facial attributes, specifically glasses, hair, and beard, on ratings of personal qualities, research results indicate that the wearing of glasses is associated with intellectualism and goodness, being bald with idealism, and wearing a beard with unconventionality and goodness. (Hellström & Tekle, 1994). Investigating the relationship between aggression and perception of anger in others from images (Hall, 2006), results show that individuals reporting higher levels of overall aggression misidentified anger from the facial expressions, showing that the interpretation of images is moderated by the end user. Prior work has shown that images are better stimuli than text for engaging with information (Jiang, Guo, Xu, & Fu, 2019). In terms of emotions, using a large number of Instagram photos, researchers have shown that color features of profile photos are linked to the characteristics of their uploader, including that color diversity is negatively correlated with romantic loneliness (Kim & Kim, 2019 In press).

c. Prior work on personas formed from quantitative data

Although the most common methods for data collection for persona creation have been qualitative in nature (Adlin & Pruitt, 2010; Cooper, 2004), several authors have suggested the collection and use of quantitative data (Brickey, Walczak, & Burgess, 2010; Lieve Laporte, Karin Slegers, & Grooff, 2012; McGinn & Kotamraju, 2008; Miaskiewicz et al., 2008; Sinha, 2003). For incidence, Brickey, Walczak, and Burgess (2010) report that a method using principal component analysis outperforms Latent Semantic Analysis and Multivariate Cluster Analysis for the clustering of persona, while Laporte, Slegers, and De Grooff (2012) propose using multiple correspondence analysis to create persona segmentations.

d. Prior work on personas in cross-cultural projects

Personas as cultural artifacts have yet to be researched, and organizations have only recently begun to consider the developing of personas for global markets (Seidelin, Jonsson, Høgild, Rømer, & Diekmann, 2014). As such, there is limited prior work on how to account for cultural differences when fashioning personas (Snyder, Sampanes, White, & Rampoldi-Hnilo, 2011). In one of the few works, Snyder et al. (2011) discuss three approaches for integrating cultural differences into persona profiles, which are: (a) a separate persona for each culture and/or task; (b) U.S.-based persona profiles with each including sections with cultural differences; and (c) one persona representing each country with the cultural differences as part of the profile. However, the researchers realized that there were few cultural differences within the target audience (Snyder et al., 2011), so the researchers developed persona profiles from several countries, just as a reminder to the end users that the product is used by customers from different countries and cultures.

In one of the limited prior works examining personas outside of the WEIRD (Western, Educated, Industrialized, Rich, and Democratic) (Sturm et al., 2015) region of the world, Putnam et al. (2012) describe two cases of using data for personas from Kyrgyzstan and the Andhra Pradesh region of India. One of the tactics employed was to use scenarios in the persona profiles to convey differences in culture and lifestyle. Cabrero et al. (2016) back co-designing personas with end users to overcome over-simplistic cultural assumptions, although this is somewhat of a standard practice. Jensen et al. (2017) propose practice theory for an understanding of cultural aspects. Hill et al. (2017) try to address the issue of whether or not multiple photos can overcome gender bias, reporting that there was limited gender stereotyping of the persona occurring with end users to begin with.

Despite the lack of prior work, the matter of developing personas for cross-cultural teams is highly important for work with both automatically generated and traditionally developed persona profiles, as many organizations are increasingly diverse with project teams that span multiple cultural perspectives. This includes international media companies that have diverse staffs and that target their content to geographically and culturally fragmented audience groups. As such, persona profile photos detailing gender and ethnicity, for example, can be interpreted differently by team members. In the following, we will describe the persona profiles generating via the Automatic Persona Generation (APG) system (Jung et al., 2017).

e. APG persona profiles

Persona profiles produced via the APG system are derived from social media data retrieved via the API of popular social media platforms, such as Facebook and YouTube. The data retrieved contains both behavioral and demographic attributes. Behavioral interaction describes how users have viewed, liked, or shared content (e.g., videos, posts), and the demographic data includes age group, gender, and location (Hoang & Mothe, 2018). As this data is not publicly available and can only be accessed by the account holders, the system uses an organization's API keys to retrieve the data, storing it in a local PostgreSQL database for processing. The strength of this automated approach is that it benefits from real user data that unobtrusively monitor the *entire* user-content interactions, reducing time and cost for generating behavioral and demographic user segments, and it provides a mechanism for integrating the two behavioral and demographic segments into a holistic persona profile.

The APG persona profiles (see Figure 2) and conventional persona profiles in general have less published prior work than the consensus (Anvari & Tran, 2013; Eridon, 2012; Goodman, Kuniavsky, & Moed, 2013; HHS, n..d.; Jones & Marsden, 2006; Mulder & Yaar, 2006; Negru & Buraga, 2013; Nielsen, 2013; Pichler, 2012; Pruitt & Adlin, 2005, 2006) concerning the presentation of persona suggests. The APG personas profiles include textual information about demographics, interests, and usage patterns (e.g., the 10 most viewed videos). The APG persona profile is enriched with social media postings (Zarrinkalam,

Kahani, & Bagheri, 2018) that are derived from real users from the corresponding behavioral segment. See published prior work for an in-depth discussion of the APG system (An, Kwak, & Jansen, 2017; Jung et al., 2017).

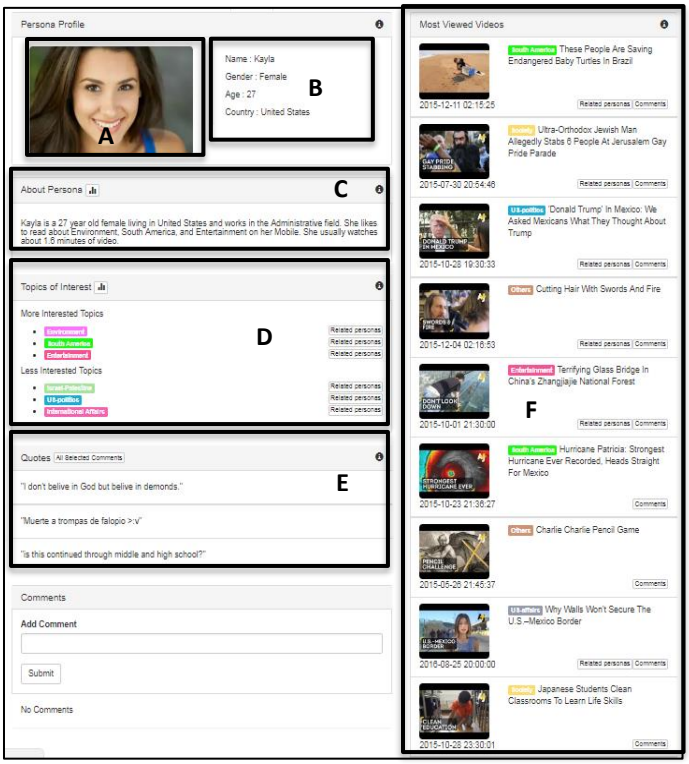

Figure 2. Example of an automated persona profile generated from the APG system.

APG creates persona profiles by automatically including appropriate features, such as name, photo, and personal features (see Figure 2). Vigilant effort has gone into the selection of the photos. For example, we bought copyrights to more than 4,000 commercial stock photos of people of different ethnicities, genders, ages, and cultural identities. The assortment of different styles to present various professions, interests, etc. can strengthen the expressive power of the persona profile, so we have purchased varies photos for each demographic group and labeled all photos with the appropriate metadata. Then, using the combination of age group, gender, ethnicity, country, etc. of a given user segment, APG assigns an appropriate photo to a persona. The photos are of the headshot-style, as can be seen in Figure 2. The overall APG methodology consists of six steps, shown in Figure 3.

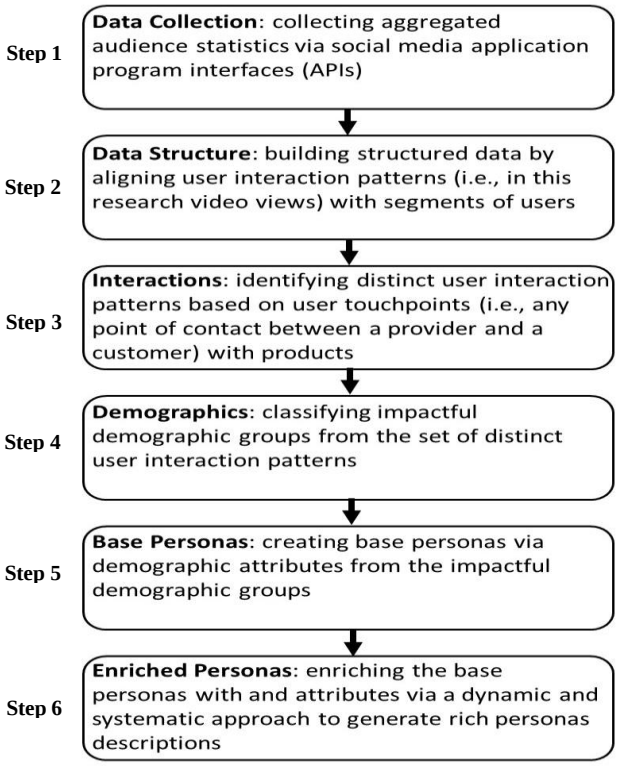

Figure 3. The APG process of leveraging social analytics data to automatically create the persona profiles.

The APG persona profiles are composed of six sections: persona introduction consisting of name, age, gender, and country (B in Figure 2), along with a photo (A). There is an 'About persona' (C) section, with expanded information. The topics of interest (D) are displayed as bullet points. There are sections 'Quotes', which is aggregated from social media users who match with a given persona (E), '10 most viewed videos' (F) and 'Potential reach' describing the total audience size that is derived from Facebook Marketing API with the corresponding targeting criteria (not visible in Figure 2).

Generally, the APG personas have less background information on personality, psychographics, and lifestyle that is typical for personas created traditionally (compare Figure 1 and Figure 2), but APG personas provide more precise and accurate information concerning user interests, interaction patterns, etc. As automated persona profiles incline to have less textual data [3], the photos carry a larger importance for conveying information concerning the personas to end users.

3. RESEARCH QUESTION AND HYPOTHESES

We are interested in knowing how different photos influence users' perceptions of personas profiles by bridging the knowledge gap between the implications of multiple photos and also the effect of adding these additional photos on the overall interaction with the other persona profiles' textual content. To achieve this goal, we formulate the following hypotheses (H) and research question (RQ):

- H1a and b: *Adding [a: contextual, b: attribute-similar] photos increases the perceived confusion relative to a headshot photo*.
- H2a and b: *Adding [a: contextual, b: attribute-similar] photos increases the perceived informativeness relative to a headshot photo.*
- H3: *Photo changes to the persona profile that cause confusion result in lower informativeness.*
- H4a and b: *[a: contextual, b: attribute-similar] photos are more often looked at than other content on the persona profile.*
- H5 and b: *[a: contextual, b: attribute-similar] photos are longer looked at than other content on the persona profile.*
- H6a and b*: [a: contextual, b: attribute-similar] photos are more often looked at than headshot photos.*
- H7a and b: *[a: contextual, b: attribute-similar] photos are longer looked at than headshot photos.*
- RQ1: *Does the photo incite associations and cultural assumptions on top of the written information?*

Hypotheses 1 through 3 rely on think-aloud protocols and focus on the reaction to the entire persona profile. Hypotheses 4 through 7 rely on eye tracking protocols, focusing on the personas profile photos. Research question one uses an interview technique, focusing on participant reaction to the personas.

Our basis for assessing these three persona profile layouts is that one photo (typically a *headshot*) is standard practice in persona profiles (Nielsen, 2013). The use of *contextual* photos is also not uncommon in personas descriptions (Nielsen et al., 2015), as it is assumed; although we could locate no prior work confirming this, that contextual photos convey additional relevant information concerning the personas that a single headshot photo does not. Using the photos of multiple people having the similar key attributes of the personas (*attribute-similar*) but different non-relevant attributes is an effort to overcome possible biases or stereotyping (Abdelnour-Nocera, Clemmensen, & Kurosu, 2013; Hill et al., 2017) that might be caused by a photo of a single individual. In our case, we choose one non-relevant attribute, ethnicity, as the persona was generated using gender and age characteristics. The notion of Mien Shiang (Bridges, 2012), i.e., Chinese face reading, for example, is based on the idea that a person's face conveys certain characteristics, such as emotion and expression (Hutchison & Gerstein, 2017). Therefore, it is a realistic assumption that a single headshot photo would engender certain stereotypes that we might want to avoid in the persona, as they divert the user's attention from other relevant information elements.

Nevertheless, we expect that additional photos of whatever type receive more attention than the simple headshot profile photo, which the eye tracking data would tell us via fixations and dwell times. However, for content engagement, such as persona profiles whose processing requires analytical thinking, it is not immediately clear how longer attention should be interpreted.

Therefore, we analyze the confusion/informativeness measures in relation to dwell times. Comparing the different persona layouts, we can measure the impact of more photos of different types on user perception.

In order to answer our research objective, we define two metrics: *informativeness* and *confusion*. We define informativeness as the conveyance of information concerning the persona, which is a definition similar to the concept used in a variety of fields dealing with information transference of (Frankel, Kothari, & Weber, 2006; Maglio & Campbell, 2000). We define confusion as a state of uncertainty concerning the persona. Uncertainty is an increasingly investigated construct (Mitchell, Walsh, & Yamin, 2005) in a variety of fields dealing with end users (Intharah, Turmukhambetov, & Brostow, 2017). Several eye tracking studies have applied comparable measures of cognitive processing (Gwizdka & Cole, 2013; Ouzts, Snell, Maini, & Duchowski, 2013). In particular, Blascheck et al. (2016) proposed triangulation of eye tracking data with talk-aloud data. We derive the informativeness and confusion of the participants from the talk-aloud records made during the eye tracking sessions. From our review, this is one of the first eye-tracking studies of persona profiles (Hill et al., 2017).

To answer our hypotheses and research question, we design two user studies: (a) a comparative study using eye-tracking, talking aloud, and post-interviews focusing on all three research questions, and (b) a qualitative interview study focusing on comprehension of the persona descriptions between two sets of personas with or without contextual photos. For both studies, we used persona profiles derived from the automatic persona generation (APG) system (Jung et al., 2017), which discovers a set of personas from online social analytics data with almost no human intervention. This research is a significant expansion of research reported in (Nielsen et al., 2017; Salminen et al., 2018).

4. METHOD

In our study, we set out to gather two types of feedback from the participants. Explicit feedback is gathered via the interviews and collects the opinions of the participants, while implicit feedback is collected via eye tracking that records the visual attention given by the participants to different information elements in the persona profiles. The subsequent sections discuss these approaches.

a. Study 1: Eye-tracking for collecting implicit feedback

For Study 1, we applied eye tracking as a methodology to address our research questions. Eye tracking is broadly used to study system usability both for prototypes and ready products (Duchowski, 2009). Eye tracking can be used to disclose interaction patterns toward navigational and content elements and to provide design recommendations for system development (Goldberg, Stimson, Lewenstein, Scott, & Wichansky, 2002).

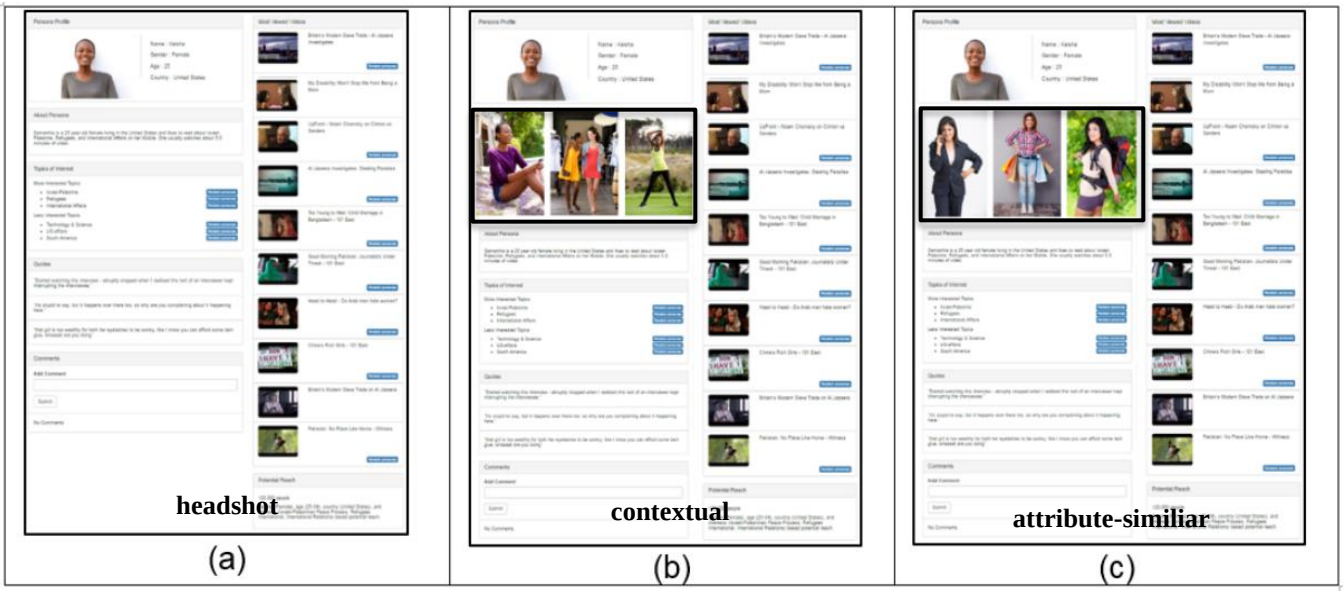

Figure 4. The three difference persona profiles displayed to the study participants: (a) is the treatment with one headshot photo, (b) is the treatment with the contextual photos (boxed in the figure), and (c) is the treatment with three additional photos of diverse young females (boxed in the figure).

Gender	Eye-tracking	Interviews	Role	Eye-tracking	Interviews
Male	15	9	Editor	9	4
Female	14	7	Producer	16	9
			Other	4	3
Total	29	16	Total	29	16

Table 1. Participant information for the study. Participants of the role 'Other', include executive, computer programmer, analyst, and marketer.

We had two stations equipped with a desktop computer, the EyeTribe eye-tracking device (Tribe, 2016), and associated software for logging the sessions. Our participants for this study were digital content creators from major, worldwide news companies. The study occurred in the participants' workplace. The EyeTribe device calculates gaze coordinates with respect to a screen by a pair of (x, y) coordinates. The device was placed at the bottom of the screens used in the study, with the angle adjusted for each participant in order to ensure each participant was in the device's trackbox to record eye movements. The eye tracking software calculates the user's eye gaze coordinates with an average accuracy of around 0.5 to 1 degree of visual angle. Using a standard participant distance from the screen of approximately 60 centimeters, the tracker's accuracy corresponds to an on-screen average error of 0.5 to 1 centimeter.

There were 30 participants, within one unusable session, resulting in 29 useable data recordings, (see Table 1) in the within-subject experimental study. The average age of participants was 33-year-old, and they were selected to reflect the staff working with news content on a daily basis and formed a diverse pool of individuals originating from 19 countries (e.g., Egypt, Georgia, Germany, Syria, UK, USA, etc.). The producers are the primary content creators of news articles and videos both for web and television, whereas the editors prepare the content for final publication, mainly for social media channels. The participants' average experience of in the news industry was seven years and three years with the current company. Their experience with personas varied, with some not that familiar with the concept prior to the study. However, we explained to each participant the concept. The motive for choosing these participants was that the researchers are developing an automatic persona generation system for their organization. They are thus the end users of the persona profiles. We did not financially compensate the participants for taking part in the study. We instructed all participants in the same manner at the beginning of the experiment about the usage of the devices and the procedure.

We showed the three treatments to each participant in a random sequence in order to mitigate order effects (Shaughnessy, Zechmeister, & Zechmeister, 2014). The three treatments were persona profiles with similar textual content (see Figure 4):

- **Treatment 1 (T1 headshot):** a headshot and text. (i.e., the persona description)
- **Treatment 2 (T2 contextual):** a headshot, additional contextual photos of the *same* person that exhibit the characteristics of the persona, and text.
- **Treatment 3 (T3 attribute similar):** a headshot, additional photos of *different* persons that exhibit the similar characteristics of the persona, and text.

Each of the treatments was denoted by various areas of interests (AOIs), as shown in the example of Figure 5. An AOI is a denoted subregion of a displayed treatment permitting the measuring of key indicators for those sub-regions. At the beginning of each trial, we welcomed the participant, introduced ourselves, briefly explained the study (i.e., using eye tracking to investigate how they use the Web), and answered any questions concerning the study.

Figure 5. Treatment 2 (attribute similar) shown as an example of the AOIs assignments for each of the three treatments. The AOIs allowed us to measure fixations and gaze for key areas of the treatments.

After completing the IRB consent form, we assigned each participant a unique ID, complete a short demographic survey, and then calibrated the eye-tracking device. Each participant completed a short practice task to familiarize with the eye tracking equipment prior to completing the actual tasks. For the actual tasks with three treatments, there were six possible orders. The EyeTribe software has the capability for random assignment of the treatments, which we employed for counterbalancing. An equal number of participants doing each of the six experiments ensures that factors are counterbalanced and eliminates ordering effects. The entire user study took approximately thirty minutes per participant. For each treatment, we presented the participant a scenario prior to engaging with the persona profile. The scenario was identical except for the subject of the story [*International Affairs / Refugees / Israel-Palestine*] that the content creator was interested in designing:

"You are creating a news video about [International Affairs / Refugees / Israel-Palestine]. You want to get some insights on how to pitch your story. As part of your investigation, you view the following persona page, looking for content on the page to see if it can help you pitch your story. Be sure and TALK-ALOUD, saying what you are looking at and why. Use the mouse as

you normally would. Click as you normally would but the links are disabled, just let the moderator know why you are clicking on some portion of the page. Once you are finished, let the moderator know."

Three researchers independently labeled confusion and informativeness for each participant and treatment (P-T pair). According to the principles of cognitive discourse analysis (CDA) (Tenbrink, 2014), we used participants' explicit cue words such as "confusing," "did not understand," and "difficult to say" to tag confusion, and expressions of extraneous information (e.g., the lifestyle of the persona: "likes the outdoors and is fit" clearly indicates more information than derived from static pictures only, for example) to label informativeness. Confusion was consequently defined as an experiment trial where the participant indicated by talking aloud that he or she was confused, and informativeness as the participant describing the persona in great detail. When there was disagreement for a given P-T, we used majority voting to determine whether the instance was coded informative/confusion. For both informativeness and confusion, coding was binary (1 = TRUE, 0 = FALSE) Similar approach of using talk-aloud records to understand users' mental states has been applied in (Eger, Ball, Stevens, & Dodd, 2007). Fleiss' Kappa interrater reliability measure indicated satisfactory agreement (k=0.71) (McHugh, 2012).

b. Study 2: Qualitative Interviews

To understand the participants' perceptions of the photos in connection with the textual information and to investigate if the photos convey information that complements the textual information, we conducted 16 qualitative interviews with participants in Study 2. The interviews were conducted after the eye tracking sessions.

As in Study 1, the interview pool consisted of a diverse group of people in terms of age, gender, and origins (e.g., Middle East, Europe, North America). The participants have different roles and work in different parts of the news media network. Half work in the interactive team with social media content in roles covering video producer, video editor, additional producer, programmer, and marketing executive. Half work for the website, their roles including feature editor, opinion editor, journalist, translator, documentarist, and web analyst. All of the interview participants participated in the eye tracking study, but not *vice versa*, as not everyone had time for both studies.

We asked the participants about their job role, tasks, and how long they had worked in the organization. Then, we were asked, "Who is a typical reader/viewer?" After this, we showed them one of the two persona profiles (see Figure 6. The two versions of the persona description in Study 2, version (A) without context photos and version (B) with context photos. Followed by a page 2 (C) that is the same for both versions. Each participant was only shown one description.) and asked questions about the persona, which was intentionally different from the eye-tracking study but still similar in order to avoid any learning effects

from participants who had also participated in the eye-tracking study. The interview ended in questions about improvements to the profiles and the overall usefulness of personas as audience representations.

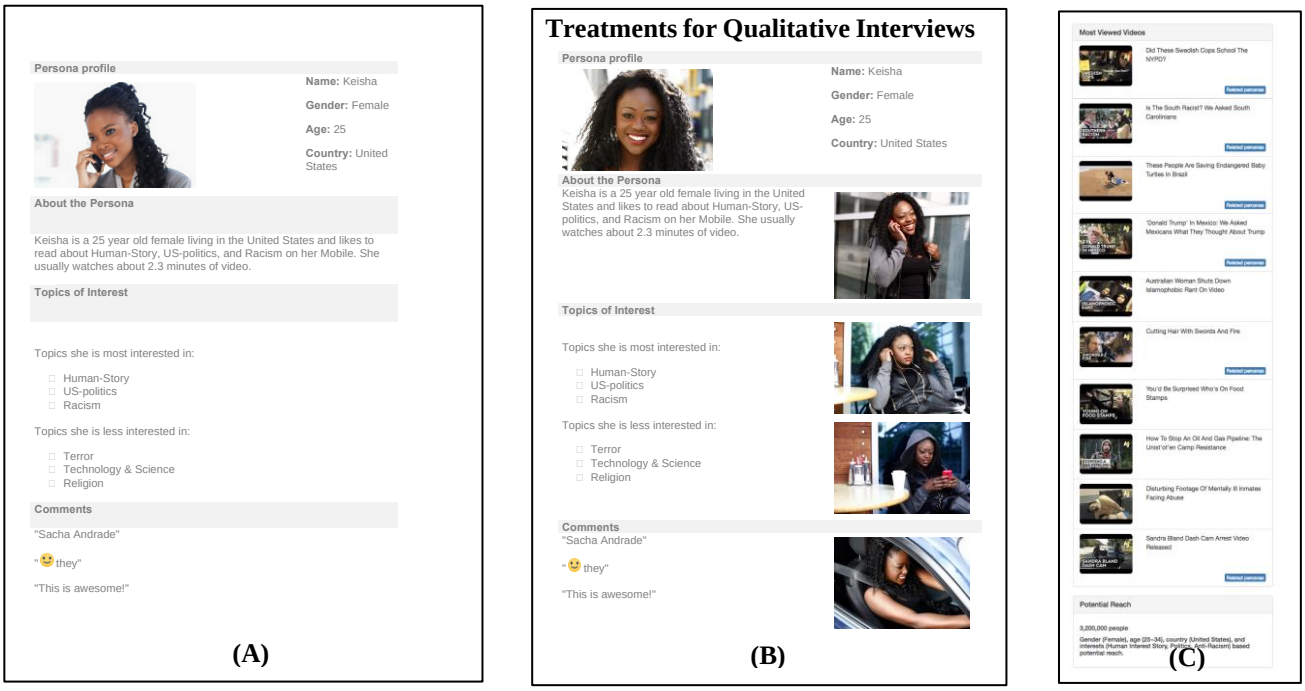

Figure 6. The two versions of the persona description in Study 2, version (A) without context photos and version (B) with context photos. Followed by a page 2 (C) that is the same for both versions. Each participant was only shown one description.

We interviewed each participant for approximately 15–30 minutes, with each interview subsequently transcribed verbatim. The transcripts were qualitatively coded (Guba & Lincoln, 1998) and from this, we identified a number of themes, such as persona reaction, most important information, evaluation of information, usefulness, photos, context, and platform use.

5. RESULTS

We report the results of our research, beginning with the eye-tracking and then follow with the qualitative interviews.

a. The results of the eye-tracking study

The eye tracking metrics are shown in Table 2. As expected, T2 contextual and T3 attribute-similair have a higher number of fixations and duration because the participants are presented with more informational content as a result of the additional photos. The fixation and duration counts are the sum of fixations and durations across all participants, measured in seconds. Fixations are periods where the eyes are focused on an AOI, and duration is the amount of time spent on an AOI.

Though the effect of treatments on the duration of fixations is small, there is a larger effect on the number of fixations; as seen from Table 1, contextual photos bring a 13-14% increase in the number of fixations. The duration is comparable for T2 photos,

but the increase for T3 photos is quite small. We conjecture that the photos were confusing, based on analysis to follow, so participants did not dwell on them.

	T1 (headshot)	T2 (contextual)	T3 (attribute-similar)
Fixation count (% rel. to T1)	16,806	18,497 (110%)	18,030 (107%)
Fixation count on photos (% rel. to profile overall)	1,501 (9%)	2,400 (13%)	2,489 (14%)
Fixation duration (*s*) (% rel. to T1)	6,283	6,572 (105%)	6,303 (100.3%)
Fixation duration on photos only (*s*) (% rel. to profile overall)	509 (8%)	759 (12%)	728 (12%)

Table 2. Eye tracking metrics for the three treatments, overall and for photos. Treatments with contextual photos get more attention.

The results of the coded confusion and informativeness analysis

Table 3 and Table 4 summarize the coding results of confusion and informativeness.

	T1 (headshot)	T2 (contextual)	T3 (attribute-similar)
No confusion	29	29	14
Confusion	0	0	15

Table 3. Confusion coding for the three treatments.

	T1 (headshot)	T2 (contextual)	T3 (attribute-similar)
No informativeness	28	10	19
Informativeness	1	19	10

Table 4. Information coding for the three treatments.

Examining H1a and H1b, we tested the effect of Treatment (T1 headshot, T2 contextual, and T3 attribute-similar) on confusion. We performed the Cochran's Q test, which is similar to a repeated-measures ANOVA for handling dichotomous responses. The result displayed a significant effect between treatment and confusion (Chi-Square=30, df=2, p=0.003). We then performed the McNemar's posthoc test for each pair of treatments to isolate the effect, with results presented in Table 5. We have a significant difference of confusion between T1 (T2) and T3 (p=0.001). Showing the multiple attribute-similar photos has a statistically significant impact on confusion. Thus, H1b is supported, but H1a is not: *adding attribute-similar photos increases the perceived confusion relative to a headshot photo but adding contextual photo does not increase confusion.*

	T1-T2 (headshot-contextual)	T1-T3 (headshot- attribute-similar)	T2-T3 (contextual- attribute-similar)
Chi-Squared	NaN	13.067	13.067
df	1	1	1
p-value	NA	0.00060	0.00060

Table 5. McNemar's test with continuity correction for each pair of treatments. The p-values are Bonferroni corrected. We note that participants' responses for T1 and T2 are identical with zero confusion.

Then, we tested the effect of treatment on informativeness to test H2a and H2b, performing the Cochran's Q test. Again, we found a significant effect of treatment on informativeness (Chi-Squared=21.13, df=2, p=0.002). We then performed the McNemar's posthoc test on each pair of treatments to isolate the effect, as shown in Table 6.

	T1-T2 (headshot-contextual)	T1-T3 (headshot-attribute-similar)	T2-T3 (contextual-attribute-similar)
Chi-Squared	14.45	5.8182	4.2667
df	1	1	1
p-value	0.00043	0.0476	0.1166

Table 6. McNemar's test with continuity correction for each treatment pair. The p-values are Bonferroni corrected.

Thus, we have a significant difference of informativeness between T1 headshot and T2 contextual (p=0.001) and T1 headshot and T3 attribute-similar (p=0.048), indicating that the persona profile with one headshot photo differs from those with contextual photos by informativeness. H2a and H2b are supported: *adding contextual photos increases the perceived informativeness relative to a headshot photo as does adding attribute-similar photos.* However, there is no statistically significant difference between the two (i.e., T2 contextual and T3 attribute-similar).

Then, we employ the Chi-Square test of independence to test H3 and found that none of the treatments showed a statistically significant relationship between confusion and informativeness. Instead, we discovered that T1 headshot has the highest number of participants with 'No confusion & No informativeness,' T2 contextual has the highest number of participants with 'No confusion & informativeness,' and T3 attribute-similar has the highest number of participants with 'Confusion & No informativeness.' From this, T2 can be interpreted as the optimal design among the ones tested (i.e., persona description with a headshot and contextual photos of the same person than in the headshot). Figure 7 illustrates the summarized results.

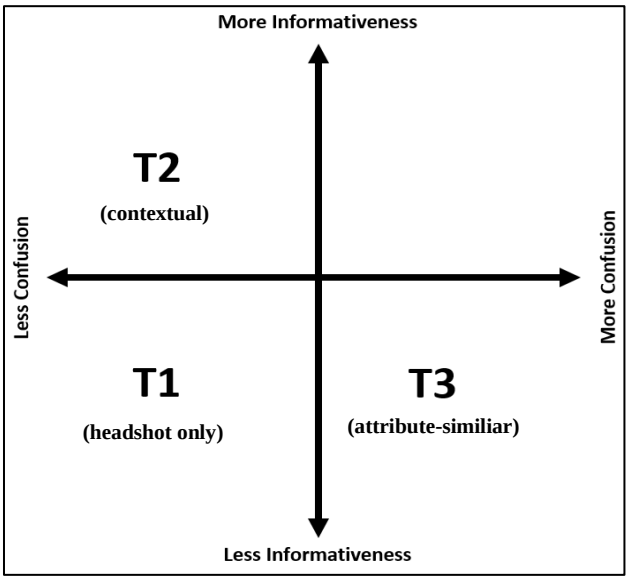

Figure 7. Informativeness and Confusion among treatments.

Examining H4a and H4b, we sum the number of fixations for each AOI for each participant for each treatment using the embedded AOIs. Further, we categorize consecutive observations for the same AOI in the original dataset as a single observation. These counts were log-transformed to meet the assumption of normally distributed errors for the linear mixed model. The AOIs were categorized according to whether or not they contained a contextual photo, with AOIs 21 to 24 marked TRUE and all others marked FALSE. Finally, this analysis was restricted to T2 contextual and T3 attribute-similar since AOIs 21 to 24 did not appear in T1. By carrying out the linear mixed model analysis, we find that the number of fixations targeting AOIs 21 to 24 is significantly larger than the number of fixations targeting other AOIs ($p < 0.001$). The results are shown in Figure 7.Table 7. The relationship between contextual photos and number of fixations.

	numDF	**denDF**	**F-value**	**p-value**
(Intercept)	1	1278	1686.3239	<.0001
CtxtImg	1	1278	57.5598	<.0001

Table 7. The relationship between contextual photos and number of fixations.

So, H4a and H4b are fully supported; the use of contextual and attribute-similar photos will attract more fixations than other content.

For H5a and H5b, we focus on fixation duration. Using the super AOIs, we find that participants spend significantly more time in AOIs with contextual photos than those without ($p<0.0001$). The results of the linear mixed model can be seen in Table 8. The relationship between contextual photos and dwell time.

	numDF	denDF	F-value	p-value
(Intercept)	1	613	25417.692	<.0001
Treatment	2	613	0.165	0.8476
CtxtImg	1	613	29.490	<.0001
log(AOI.area)	1	613	148.610	<.0001

Table 8. The relationship between contextual photos and dwell time.

So, H5a and H5b are fully supported; the use of contextual and attribute-similar photos will attract more attention than other content. Furthermore, there is a positive effect of AOI area on time spent ($p<0.0001$). In this analysis, the total duration within each AOI was summed for each participant for each treatment, again excluding T1 headshot. Figure 8 illustrates the findings. Generally, the duration of fixations in non-contextual photos is more varied, including shorter dwell times, whereas the density distribution for contextual and attribute-similar photos is focused on higher dwell times.

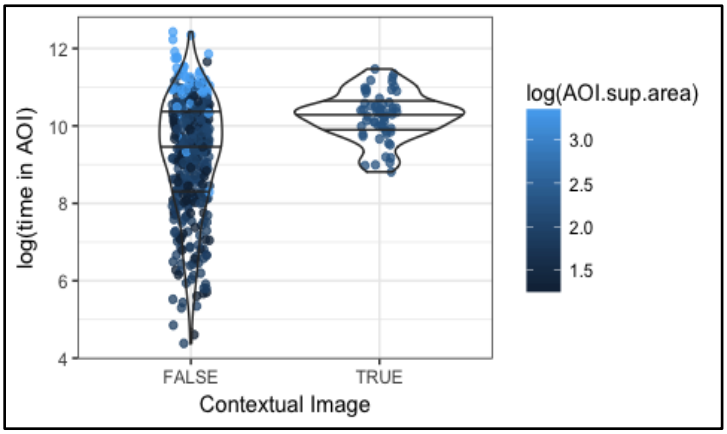

Figure 8. Time spent in contextual and attribute-similar photos compared to other content. The color coding represents the area – lighter color indicates larger areas, so one can see that (for non-contextual photos at least), the larger areas had longer total durations.

For this H6a and H6b, we calculated the area of AOI 21 by subtracting AOIs 22–24 from it, because AOI 21 is only categorized as the embedded AOI when the participant is not focused on AOIs 22–24, which are within AOI 21. We found no significant difference between the number of fixations targeting AOIs 21–24 compared to AOI 1 ($p=0.19$). There was a significant effect of AOI area ($p< 0.0001$), though this appears to be driven primarily by the small number of fixations on AOI 21. The results can be seen in Table 9. The relationship between contextual photos and number of fixations.Table 9.

	numDF	denDF	F-value	p-value
(Intercept)	1	249	960.9925	< 0.0001

	numDF	denDF	F-value	p-value
Treatment	1	249	0.3705	0.5433
CtxtImg	1	249	1.7139	0.1917
log(AOI.area)	1	249	125.4173	< 0.0001

Table 9. The relationship between contextual photos and number of fixations.

So, H6a and H6b are not supported; headshot photos are looked at just as much as contextual and attribute-similar photos. We also did a pairwise comparison of T2 and T3. This analysis was restricted to AOIs 21–24 in T2 and T3. There was no significant difference in the number of fixations between T2 and T3 (p=0.26). There was a significant effect of AOI area when each AOI was kept separate rather than combined into a single super AOI. There was no effect when comparing only total fixations per participant (i.e., all fixations in AOIs 21–24 in T2 against T3; p=0.32). The results are illustrated in **Error! Reference source not found.** and Table 10. ANOVA of the total number of fixations between T2 contextual and T3 attribute-similar.

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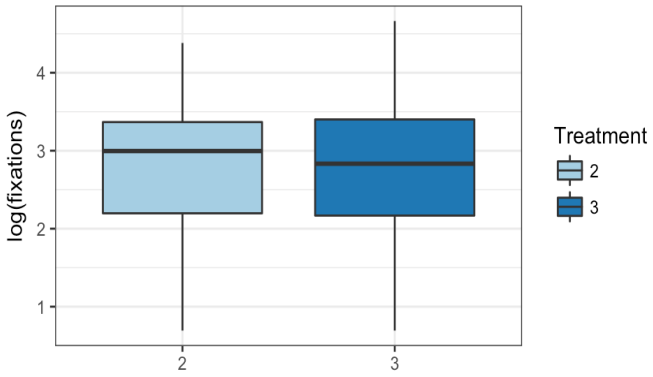

Figure 9. Comparison of the total number of fixations between T2 contextual and T3 attribute-similar. This analysis only considered the contextual and attribute-similar photos.

	numDF	denDF	F-value	p-value
(Intercept)	1	192	937.2101	< 0.0001
Treatment	1	192	1.2576	0.2635
log(AOI.emb.area)	1	192	120.0946	< 0.0001

Table 10. ANOVA of the total number of fixations between T2 contextual and T3 attribute-similar.

The analysis for H7a and H7b used the super AOIs so that we compare AOI 21 (contextual photos) to AOI 1 (static profile photo). By conducting the statistical analysis, we find that participants did spend significantly more time focused on contextual photos ($p<0.0001$), as shown in Table 11. The relationship between contextual photos and number of fixations.

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	numDF	**denDF**	**F-value**	**p-value**
(Intercept)	1	85	10577.818	< 0.0001
Treatment	1	85	0.475	0.4925
CtxtImg	1	85	65.958	< 0.0001

Table 11. The relationship between contextual photos and number of fixations.

So, H7a and H7b are fully supported; the use of contextual and attribute-similar photos will attract more fixations than a headshot photo. **Error! Reference source not found.** shows the dwell times. Figure is a bump plot where each line represents a participant. The majority of the lines show a positive slope, representing the longer duration spent in contextual and attribute-similar photos compared to the headshot photo.

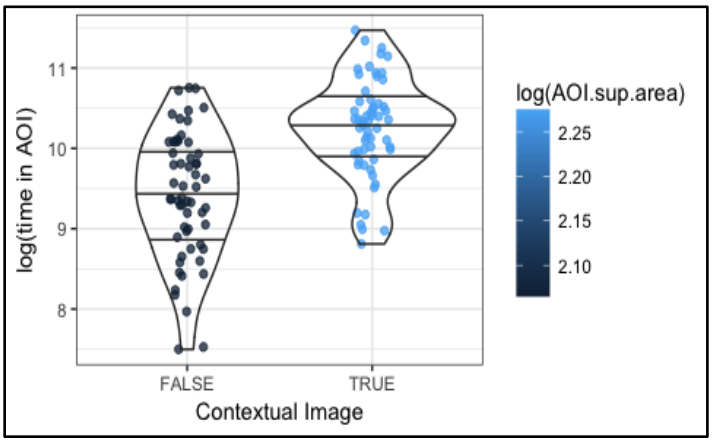

Figure 10. Dwell times in contextual and attribute-similar photos (TRUE) compared to headshot photo (FALSE). The results show a tendency to spend more time in contextual photos.

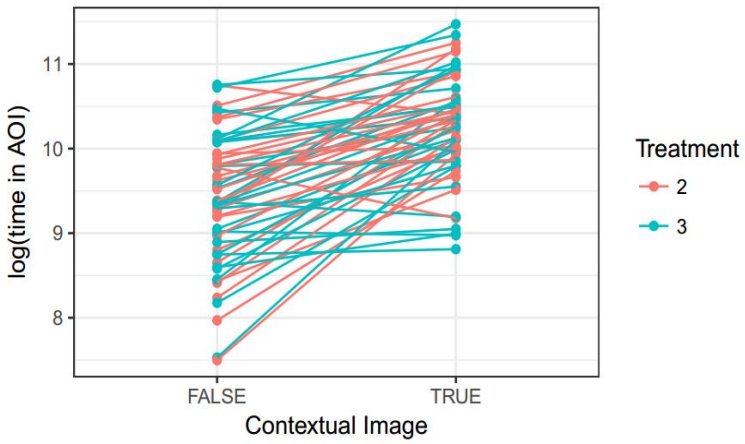

Figure 11. Dwell times in contextual and attribute-similar photos compared to static photos. Each line represents an individual participant. There is variation among individuals, but, generally, each person is spending more time looking at the contextual and attribute-similar photos.

We also tested the difference between attribute-similar and non-attribute-similar photos. This includes only T2 and T3, and only compares the contextual photos (i.e., AOIs 21–24). As before, the super AOIs are used rather than the AOIs directly. This also controls for differences among individuals. There was no significant effect of treatment (p=0.26), as shown in Figure . There was no difference in total duration in contextual photos in T2 versus T3. Because there was only one Super AOI included, this area was not evaluated.

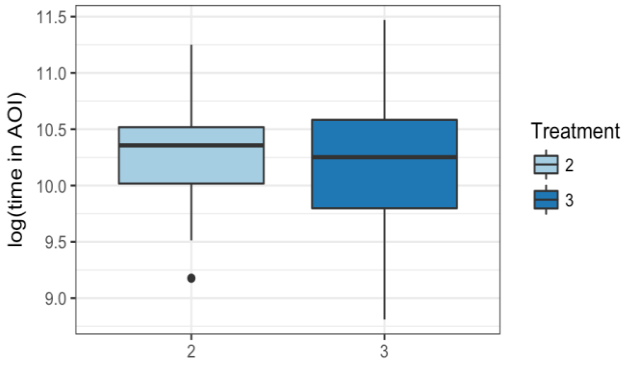

Figure 12. Comparison of total duration of fixations between T2 and T3. This analysis only considered the contextual and attribute-similar photos.

Results of the qualitative interviews study

We report the results of the qualitative interviews based on the analysis of the data in order to address RQ1. In total, the transcripts of the qualitative interviews contained 17,784 words and 1,933 unique words, for a vocabulary density of 0.109. Table 12 shows the top ten most frequently occurring terms and the top ten most frequently occurring terms with stop words removed.

Top Term (All)	Count	Percentage	Top Term (Content)	Count	Percentage
like	244	1.37%	think	167	0.94%
know	178	1.00%	people	97	0.55%
think	167	0.94%	interested	84	0.47%
people	97	0.55%	stories	75	0.42%
it's	93	0.52%	videos	62	0.35%
mean	91	0.51%	story	57	0.32%
just	90	0.51%	she's	56	0.31%
yeah	89	0.50%	things	54	0.30%
interested	84	0.47%	news	45	0.25%
i'm	82	0.46%	human	43	0.24%

Table 12. List of Top Terms (All and Content) From Qualitative Interviews

Relating to the persona as an Individual human being

To measure the reality of the personas, we first ask whether the participants know someone who is like the persona (see Figure 6A). Nearly all the participants have met a similar person, upon which they base the familiarity via gender, age, and interests. Interestingly, three of the participants take a point of departure with the photo showing an African-American female and compare the interest in racism to either their own background or to people they know of similar race.

(P16, version B) *"I had a lot of it because of my color, you know; I was the only little dark girl in school, so I'm very passionate about that."*

(*P15*, version B) *"I mean, you are going to be hard-pressed to find an African-American woman in the United States right now, who's that age, and who's not interested in the US politics or racism. Just because of the current climate there*"

(P14, version A) *"Not necessarily an African-American maybe, of color, but age and someone who's living in the United States – yes. I have. A couple of my cousins who are around her age 25-years-old and living in the United States. They're interested especially about because they're also Filipino-American."*

Only one participant had never met a person resembling the persona, and one had briefly met someone but does not have any acquaintances that resemble the persona. Examples of contextual focus on aspects of personas, five terms on either side, are:

- *... she is mid 20s and African American girl from the United States ....*
- *... I know a handful of African-American women in the US ....*
- *... hard-pressed to find an African-American woman in the United States ....*
- *... have. Yeah. Not necessarily an African-American maybe, of color, but ....*

- *... would say, just because she's African American or black American or ….*
- *... but you know, as an African American it seems intuitive that she ….*
- *... from a 25 year-old African American. Yeah. I have but I'm ….*
- *... into there because she's an African American woman or racism. Her viewing ….*

The textual information on topics of interest (see Figure 6A and B) makes some participants extrapolate on the persona beyond the presented information based on the person presented in the photo. They draw on their personal experiences, and the focus on race creates an explanation for the persona's interest in racism.

(*P1,* version A) *"I'm already having story ideas for her I could do a story on. Because since Trump is the president now I would really look at any racism attack since Trump has been very vocal about Mexicans and blacks and all that. I think I would be chasing the story that had affected a black family or how the Trump presidency will affect people that are called, as you know, colored."*

(P6, version A) "*I would say so yes, because it is human stories I would say, just because she's African American or black American or how you term it. I wouldn't say that would separate her from any of the race related stories that are going on all over the world*"

In general, the participants find the persona profile realistic. As can be seen from the quotes, the participants base an understanding of the persona's interest in racism on the photo, and they then add their own cultural knowledge of African-Americans to create a story of a culturally aware person. This tells us that the photo does incite associations and assumptions on top of the textual information. In this case, the photo incites racial issues that are not part of the persona profile, thus drawing on end user's internal biases. The photos provide confirmation of the participants' understanding of the persona. Examples of contextual focus on interests of personas, five terms on either side, are:

- *... to cover a lot of stories that she is interested in ….*
- *... try and lead with human stories and that is obviously one ….*
- *... you could do like women stories I think she would have ….*
- *... is a percentage of lighter stories. because obviously, she has her ….*
- *... politics or racism, human interest stories, it would be nice to ….*
- *... likes to read the human stories that's….US politics, racism. She ….*
- *... she's interested in human stories, what's happening in the world ….*

Contextual photos

The contextual photos seem to support the textual information, which may relate to the prior work in the use of peripheral information (Maglio & Campbell, 2000). This is seen in the quote below; the participant perceives the persona based on both the textual and the visual information and also on personal assumptions. The photo indicates that the persona uses her phone a lot, which makes P4 extrapolate on her behavior and P9 on who she is as a person and how that relates to her topics of interest.

(P4, version B) "100% on her mobile phone, maybe on the bus or commuting, perhaps at work. People are constantly checking their newsfeed. Again, this is not a problem of how I work, but I generally find a lot of my news by going through my Facebook timeline because someone shared it or I have liked Al Jazeera's page. And these stories come up and this is how I get driven to the stories. I personally, and I am in a similar age to her and I guess in a similar background, I personally find all my news on my phone, and it won't be going to a website. I would be diverted to the[m] via a social account."

When the participants are asked where the persona will be when she consumes content, there is no difference between the descriptions without contextual photos (Figure 6A) and those with (Figure 6B). The common reference is that she is on her phone while commuting, at lunch, or at work. The participants who were shown more photos come up with slightly more places like the bathroom or in the queue, but this is not noteworthy.

(P14, version B) "*In the metro, maybe just traveling from her home to work. When she's not doing anything else. And then maybe when she gets home maybe she still spends some time reading stories on Facebook while checking the other status' or what's going on with her friends on Facebook."*

(P2, version B) "*[She is in] "a coffee shop with Wi-Fi, She would see it on a Mac, an iPad or her phone. Something like that."*

The quote below shows how the participant is trying to interpret the photos together with the information on video consumption.

(P2, version B) *"I'm giggling because it's stuff that I look at. some of it. sort of to distract yourself. It's very interesting it show you the age group and the generation and how different all of us are and how we kind of have the same, we go back to the same things. I can see her interests, I can see the racism, politics, interest in animal welfare, "cutting hair with swords and fire" - one of those things we all look at. You'll be surprised who's on food stamps, humanitarian. and "disturbing footage of mentally ill inmates facing abuse" - humanitarian. It matches with her."*

Examples of contextual focus on where persona consumes content, five terms on either side, are:

- *... her mobile phone maybe on the bus or ....*
- *... them she is on her phone. the driving I'm unsure about ....*

- *... that she is on her phone a lot. no I don't ….*
- *... like watching it on her phone or when you are like ….*
- *... bus so maybe on her phone I would say. 'Cause she's ….*
- *... She's very active on her phone so she's probably sharing. Quite ….*
- *... this one she's on the phone so she's listening, this one's ….*
- *... got her fingers on the phone so she might actually be ….*
- *... is because she's got a phone constantly on her hands, apart ….*

Richness of Information

Though the contextual photos increased the amount of information derived from the personas, they did not provide the participants with the background information often found in typical persona profiles. When asked if the participants found the level of information proper in connection to their job, several expressed a desire for more information. The information that the participants' requested is broadly three categories:

- **Background information** to help the user understand the persona: education, job, where in the U.S. she lives, etc.
- **Peripheral information** to help when producing content: that she reads, when she reads, if she watches videos partly or wholly, her rate of engaging with the content on social media, etc.
- **Information validity** concerning the data sources, how representative is the description, explaining definitions

Since automatically generated personas do not currently include this level of information, the participants, in some cases, are left either lacking the details on persona attributes, or 'filling in the gaps' based on their own experiences, biases, and stereotypes that they project on the photos. Although, these may occur with personas of other types also.

6. DISCUSSION AND IMPLICATIONS

These results represent a step toward defining the optimal information content for persona profiles, which, in turn, represent a novel type of analytics and *persona analytics* that is based on showing users behaviorally accurate user archetypes, thus complementing number-based information.

Our aim was to investigate if more photos are helpful in persona profiles and assist in alleviating the terse textual data in automatically generated persona profiles. The quantitative analysis results show that having more contextual photos significantly improves the information end users get from a persona profile. However, showing photos of different but similar people creates confusion and may lower the informativeness. Also, from the qualitative analysis, we learn that the choice of pictures results in mixed interpretations of the persona that are biased by the participants' experiences and preconceptions. Both

the headshot and contextual photos seem to support cultural assumptions and simplistic explanations for the persona's interest in, for example, racism.

Indeed, our thought-provoking findings relate to projections by participants of their experiences to the personas on the basis of photos they are seeing in the profiles. While being more informative, photos are also subject to interpretations. The cross-cultural pool of participants exhibits the diversity associated with the use of photos; some had the first-hand experience in racism, while others expressed sympathy for the African-American person in the persona photo. We postulate that *as the diversity of the user base increases, so does the number of diverse interpretations of ambiguous persona information*, specifically pictures. Though, as noted in (Salminen et al., 2017), more work on the impact of culture on persona perception is needed, and we acknowledge that our work is a starting point toward this goal.

The end users rely on the photos, including the people and the objects within them, to craft their own story about the circumstances of the persona. This end user projection can be understood as an inherent psychological trait of human cognition (Machover, 1949), and it is not realistic to undertake to change it. Thus, it becomes difficult for persona creators to control the mediated information, a key constraint for persona analytics, as pictures potentially disorientate the user from more important information. This discovery highlights the *design power* of both individuals and algorithms when choosing information content for persona profiles. We propose two solutions: (a) mitigating bias-inducing information content as much as possible, or (b) adding an additional layer of information that enables the end user to better understand the diversity of the data of the *group* the persona is based on.

In terms of effort to process the additional photos, we set out to find how manipulating photos of a persona profile influences users' visual interaction with the persona. We measured various metrics, including frequency of fixations, dwell time, and confusion versus informativeness. We separated photos by marking them as AOIs. We find support for contextual and attribute-similar photos are more often looked at than other content. This seems reasonable, as additional information is presented relative to a headshot only profile. Also, we find that contextual and attribute-similar photos are longer looked at than other content and longer looked that than headshot photos. Relating this to informativeness and confusion, more time spent in a treatment indicates higher perceived informativeness, at least for attribute-similar photos.

The other findings show that contextual photos are longer looked than other content, but this did not result in additional confusion. Moreover, adding photo content to the persona did not significantly increase the dwell time. Using dwell time as a measure of cognitive effort (Gwizdka and Cole, 2013), we can claim that additional photos, although increasing the cognitive load of users, did not result in users becoming worse off. In previous work, Arapakis et al. (2014) discovered that attention and

gaze differ across content according to their level of interestingness. In line with their findings, we thus expect that if the additional photo content drives attention, it is also perceived interesting. However, since we do not explicitly measure interestingness, this association is implicit in our study and could be explored in future studies. In addition, more experimentation is needed to determine the point of diminishing returns, where the information gain from additional visual elements results in such additional cognitive cost that exceeds the marginal information benefits. Since the layout of the persona system is readily available for modification, it is possible to experiment with different layouts for data representation by altering the elements of the persona profile in future studies.

Connecting to prior work, our findings have implications for persona profiles, especially on the lighter-weight variations, such as ad-hoc personas and proto-personas (Gothelf, 2012; Norman, 2004). Findings also confirm the premise investigated by Hill et al. (2017) that is related to the picture choice affecting how end users interpret personas. While Hill et al. (2017) found that the persona photo did not induce gender stereotyping, our findings show that the photo does engender racial and cultural stereotyping, especially with the diversity of the underlying audience groups.

To our foundational question "is using more photos better than one photo?" we respond "yes and no". On one hand, the analysis demonstrations that informativeness increases with contextual photos. On the other hand, it becomes difficult, perhaps impossible, to control the interpretation of the persona, and thus that of the underlying data, as shown by the qualitative analysis. As we noted, it is not only the number of photos that counts but also their type. Therefore, more pictures, even though they are of a single person, should be used with caution and tested to ensure they convey the attributes intended and do not convey attributes unintended. Also, as shown by the eye tracking data, additional photos require more interaction with personas.

Finally, any given study has room for improvement. First, in the future, we could consider using a more formalized measure for informativeness such as information intake (Gwizdka and Cole, 2013), as well as incorporating other stated measures such as interestingness. Second, the experimental setting is prohibitive to natural engagement with technological systems; letting users freely engage with the system might provide additional interesting findings that did not emerge during the experiment. More particularly, three approaches can be taken in future studies: (a) use of complementing data sources such as click maps to better understand users' visual interaction with the system, (b) record user behavior with a live system instead of static layout photos, and (c) increase the number of variations to cover a larger share of the space of possible designs. For the latter, multivariate testing is a potential approach, so that more manipulations are applied simultaneously, thus closing in on the "optimal design" for automated personas. Third, informativeness was problematic to code due to its multi-dimensional nature and was a source of most disagreement among the coders. More specific measures could be used in future work. Fourth, we

could also leverage more nuanced implementation of Additional studies could also explore how stock photos compare against more authentic social media profile pictures. To sum up, there are several ways to build upon this research in order to increase understanding of users' visual interaction with online persona representations.

In conclusion, we postulate a tradeoff exists among informativeness, confusion, and perceptional bias when increasing the number of information elements in persona profiles. Determining the optimum number of calls for awareness of how the information is perceived by the end users. Accordingly, more research is needed to determine the ideal persona layout in terms of information content and type in a variety of contexts. Methods such as multivariate testing with actual users can aid in approaching the development of optimal persona profiles. Furthermore, the results point to, when developing personas, that the end users within the organization need to be taken into account prior to deciding on the information content of the persona profile.

7. CONCLUSION

Our study contributes to both theory and practice. Personas can be viewed as one form of data representation that is strictly different from numbers and graphs, and oftentimes more compelling to both unsophisticated and sophisticated end users alike. Given the generally known limitations of information processing and Web layouts, determining the boundaries of persona representation forms a relevant research problem. We establish that photo content is a strong driver for attention, and also results in a higher degree of perceived informativeness. We also establish that the nature of the photos matters and that photos with a logical connection to the persona seem to result in more desirable effects. In this sense, we concur with Hill et al. (2017), who also studied the design implications of persona profiles, and argue that the persona representation might carry gender-stereotypical meanings. However, our findings differ from theirs in that, unlike our findings, they found that the persona text received considerably more attention than the photos. These differences most likely illustrate the importance of different design choices in driving users' attention, as their layout had substantially more text and the text was more prominently placed than in our profiles.

In the larger context, our study can be viewed as an attempt to summarize behavioral social media data into a meaningful format that the decision-makers can intuitively understand and apply in their professional tasks. For example, content creators in the media company are using the automatically generated personas to direct their content creation efforts. Understanding the personas as depictions of real readers helps the journalists write articles that resonate with different audiences. Based on this research study, we now know that the addition of contextual photos has the potential of adding informativeness, without having a significant negative cost.

However, the choice of those photos should be done carefully, because they can become very central when the end users are interpreting the personas. For example, the participants seeing the contextual photos were making comments such as "*from US, living a good life, can't relate to refugees*" – although this is additional information, we must consider whether it is the type of information that facilitates the completion of the end users' tasks. In the worst case, the additional photos may unconsciously influence the end users to project their own stereotypes, biases, and attitudes toward the viewed persona.

This research represents an initial step in the direction of defining an optimal information content for persona profiles that in turn represents a novel type of analytics and persona analytics based on showing users accurate user archetypes that complement number-based data representations and presentations. Our specific research objective was to investigate whether or not more photos are of value within persona profiles to assist in alleviating terse textual data in automatically generated, sparse, or ad-hoc persona profiles. The end users rely on the photos, both the people and the objects within them, to craft their own story about the circumstances of the persona. This projection is an inherent psychological trait of human cognition (Machover, 1949), and it is not realistic to assume that we could or even should change this human attribute. This makes it difficult for the creators of personas to regulate the mediated information, and it represents a key constraint for persona-based analytics, given that the biases may disorientate the end user from more important informational attributes concerning the persona. This discovery highlights the influence possessed by designers when selecting the information content of persona profiles. We suggest two potential solutions, which are (1) attempting to mitigate any bias-inducing information content as much as possible and (2) including another layer of information that a user can choose to better understand the inherent diversity of the data the persona is based on. With such actions, we can begin the evolution towards more rigorous research into the design of persona profiles, including the synergistic mixing of headshot picture, contextual photos, and supporting textual information.

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