
Confusion and information triggered by photos in persona profiles

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ABSTRACT

We investigate whether additional photos beyond a single headshot makes a persona profile more informative without confusing the end user. We conduct an eye-tracking experiment and qualitative interviews with digital content creators after varying the persona in photos via a single headshot, a headshot and photo of the persona in different contexts, and a headshot with photos of different people with key persona attributes the gender and age. Findings show that contextual photos provide significantly more persona information to end users; however, showing photos of multiple people engenders confusion and lowers informativeness. Also, as anticipated, viewing additional photos requires more cognitive focus, which is measured by eye-tracking metrics; 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 need to consider the intended persona use objectives when selecting photos and when producing persona profiles. Using contextual photos can improve informativeness, but this demands more cognitive focus from end users. Thus, adding contextual photos increases the perceived informativeness of the persona profile without being obfuscating, but multiple photos of different people do evoke confusion about the targeted persona.

1. Introduction

A persona is a fictional person representing a user segment that is usually presented in a one- or two-page persona profile (Nielsen, 2013). Although for some years in computer science and other fields (Cooper, 2004), personas have been integrated in the software design process, it is difficult to decide how to best create persona profiles (Grudin and Pruitt, 2002; Hill et al., 2017; Marsden and Haag, 2016; Pruitt and Adlin, 2006) as one must decide what information to include and what to exclude (Hornbak & Oulasvirta 2017); however, little rigorous research has been done into designing persona profiles, especially concerning using photos within these profiles. Over the years, a *de facto* layout of the persona profile has been developed (Nielsen et al., 2015) that includes a one or sometimes a two page description with a photo, most often a headshot, of a person representing the user segment, as shown in Fig. 1.

Yet, there exists “no rigorous or even rational basis for selecting details to attribute to the persona” (Voil, 2010, p. 3). However, persona creators have the critical need to understand the design implications diverse content has on how end users perceive the personas. This understanding facilitates developing persona profiles that are accurately

designed and that can be improved upon. Unfortunately, there is a limited range of studies systemically examining different profile layout options, which is why we take the opportunity to partially address such shortcoming by experimentally researching three persona layouts in order to determine which layout is most optimal.

Specifically, photos' impact is not often researched, and to our knowledge, no previous study examined the effects and the potential issues the photo might pose when shown to end users, especially in the context of 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 and 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 (Pröbster et al., 2018), and a single photo may convey cultural assumptions, causing end users to associate stereotypical attributes to the person in the photo (Viana and Robert, 2016).

In this research, we specifically investigate tensions resulting from such biases by using multiple photos in two different presentation layouts for a single persona. The layouts are: (a) contextual: additional



Fig. 1. A typical persona profile layout with notes denoting sections included; modified from (Righi and James, 2007).

photos of the same person in different contextual situations, in this case, the persona seen at work and in 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 workplace interviews with online content creators whose job goals include reaching a global audience. Our findings show that end users' visual interactions with the persona profiles 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 primary end product in the persona development process. Because personas have claimed benefits (Adlin and Pruitt, 2010; Beyer and Holtzblatt, 1998; Dharwada et al., 2007; Drego and Dorsey, 2010; Eriksson et al., 2013; Friess, 2012; Goodwin and Cooper, 2009; Guðjónsdóttir and Lindquist, 2008; Judge et al., 2012; Massanari, 2010; Miaskiewicz et al., 2009; Pruitt and Grudin, 2003; Rönnkö, 2005), improving the design process is critical, as the procedure of creating personas is reportedly costly, difficult, and lengthy (Drego and Dorsey, 2010; Flaherty, 2018; Nielsen and Hansen, 2014; Viana and Robert,

2016). Given this cost, it is essential to fully as much as possible optimize the persona profile end product. The optimal design will further increase personas' applicability and usefulness in real decision-making circumstances by organizations that rely on personas as a source of audience, user, or customer insights.

We are specifically interested in how photos affect interactions with the persona profiles by end users as part of an ongoing research project aiming to automate creating persona profiles (An et al., 2018a, 2018b; Salminen et al., 2017). Determining the optimal content, layout, and photo of automatically generating personas 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 shows how personas can be automatically generated from social media data by retrieving demographic groups' content interaction metrics using application programming interfaces (APIs) and computing them (e.g., non-negative matrix factorization) (Jung et al., 2017; Miaskiewicz et al., 2008). By decreasing the amount of textual information associated with automatically generated personas, photos are potentially even more important within the persona profile, which is common also with ad-hoc and prototypical personas (Norman, 2004; Gothelf, 2012). Given this, understanding persona profiles' design is essential.

In this research, we propose persona profiles that are more informative but less confusing via user study findings, with initial results reported in Salminen et al. (2018). These research results can impact 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 automatic persona profiles generation.

2.1. 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 et al., 2017), this is at odds with findings from other domains (Hum et al., 2011; Rainie et al., 2012; Reiners and Alexander, 2013; Wu et al., 2015) that show photos receive a significant amount of focus. Most personas research present the photo as an integral and necessary part of the persona profile (Grudin, 2006), relying on automatic person recognition (Banaji et al., 2015; Bargh, 2014; Higgins, 1996); although, such processes may be prone to biases (Banaji and Hardin, 1996; Fiske, 2000).

It has been noted that the number of image-based persona studies is lacking (Nieters et al., 2007). Persona profiles' textual content has been studied by a few researchers (Floyd et al., 2008; Junior and 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 only examined the textual information and not the accompanying profile photo. Two prior works have surveyed if illustrations make personas memorable (Long, 2009; Nieters et al., 2007), with conflicting conclusions as to whether drawings are better than photos.

There has also been some research indicating that images make personas memorable. Nieters et al. (2007) noted that context images where the person performed some action not only made the persona more memorable, but they also instilled greater confidence in the persona content, enabling users to 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.

2.2. Image research in other domains

In work from non-persona domains, researchers have investigated the effect of photos on trust. In an experiment using commercial website images, photos had no significant effect on the trustworthiness of companies; although, the presence of photos increased a poorly-performing company's perceived trustworthiness but decreased trustworthiness for companies with good reputations (Riegelsberger et al., 2003). However, in a similar study (Bente et al., 2012), trustworthy photos increased the company's positive reputation and were correlated with higher purchase rates. No photo led to distrusting companies with no reputation, suggesting 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 positively affect viewer reaction (Baker et al., 1977); although, this reaction is moderated by the perceived attractiveness and gender of the end user (Sim et al., 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, or their ages or gender (Bakhshi et al., 2014). Comparing the effect of images on end user support for military campaigns, research reports that different contextual photos affect campaign support (Bauer and Carpinella, 2018).

Early images studies noted how quickly people can recognize faces and even recall faces from memory (Bruce and Young, 1998). Investigating the effect of facial attributes, specifically glasses, hair, and beard, on personal qualities' ratings, research results indicate that wearing glasses is associated with intellectualism and goodness, being bald with idealism, and having a beard with unconventionality and goodness (Hellström and Tekle, 1994). Investigating the relationship between aggression and the perception of anger in others from images (Hall, 2006), results show that individuals reporting higher levels of overall aggression misidentified anger from facial expressions, showing that end users moderate image interpretation. Prior work shows that images are better stimuli than text for engagement (Jiang et al., 2019). In terms of emotions, using a large number of Instagram photos, researchers show that the color features of profile photos are linked to their uploader's characteristics; this reveals that color diversity is negatively correlated with romantic loneliness (Kim and Kim, 2019 In press).

2.3. Prior work on personas formed from quantitative data

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

2.4. Prior work on personas in cross-cultural projects

Personas as cultural artifacts have yet to be researched, and organizations only recently began considering developing personas for global markets (Seidelin et al., 2014). As such, there is limited prior work on how to account for cultural differences when fashioning personas (Snyder et al., 2011). In one of the few works with this focus, 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) US-based persona profiles with each including sections with cultural differences; and (c) one persona representing each country with 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 they developed persona profiles from several countries to remind 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) described two cases of using data for personas from Kyrgyzstan and the Andhra Pradesh region of India. One of the tactics employed used scenarios in the persona profiles to convey culture and lifestyle differences. Cabrero et al. (2016) co-designed personas with end users to overcome over-simplistic cultural assumptions; although, this is a somewhat standard practice. Jensen et al. (2017) proposed practice theory for understanding culture. Hill et al. (2017) tried to address whether or not multiple photos could overcome gender bias, reporting that there was limited gender stereotyping occurring with end users to begin with.

Despite the lack of prior work, 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 spanning multiple cultural perspectives. This includes international media companies with diverse staffs 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 generating persona profiles via the automatic persona generation (APG) system (Jung et al., 2017).

2.5. APG persona profiles

Persona profiles produced using 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 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 and 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 Fig. 2) and conventional persona profiles generally have less prior published work than the consensus (Anvari and Tran, 2013; Eridon, 2012; Goodman et al., 2013; HHS, n.d.; Jones and Marsden, 2006; Mulder and Yaar, 2006; Negru and Buraga, 2013; Nielsen, 2013; Pichler, 2012; Pruitt and Adlin, 2006) concerning persona presentation. The APG persona 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 posts (Zarrinkalam et al., 2018) that are derived from

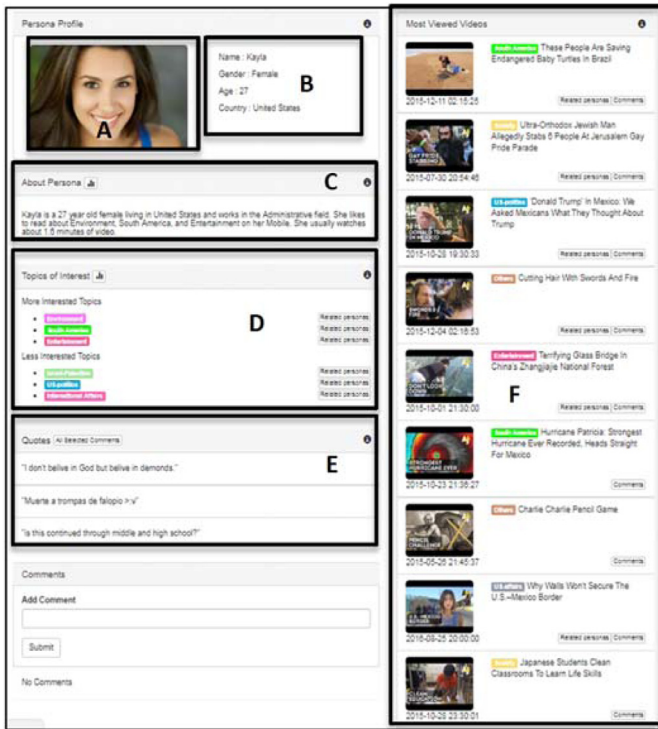


Fig. 2. Example of an automated persona profile generated from the APG system.

real users in the corresponding behavioral segment. See prior published work for an in-depth discussion of the APG system (An et al., 2017; Jung et al., 2017).

APG creates persona profiles by automatically including appropriate features, such as name, photo, and personal features (see Fig. 2). A vigilant effort has gone into the selection of the photos. For example, we bought copyrights to more than 4000 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 various photos for each demographic group and have 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 Fig. 2. The overall APG methodology consists of six steps, shown in Fig. 3.

The APG persona profiles are composed of six sections: persona introduction consisting of name, age, gender, and country (B in Fig. 2), along with a photo (A). There is an ‘About person’ (C) section, with expanded information. The topics of interest (D) are displayed as bullet points. There are sections like ‘Quotes’, which are 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 Fig. 2).

Generally, the APG personas have less background information on personality, psychographics, and lifestyle typical of traditionally-created personas (compare Figs. 1 and 2), but APG personas provide more precise and accurate information concerning user interests, interaction patterns, etc. As automated persona profiles tend to have less textual data [3], the photos are more important for conveying information concerning the personas to end users.

3. Research question and hypotheses

We are interested in knowing how different photos influence users’

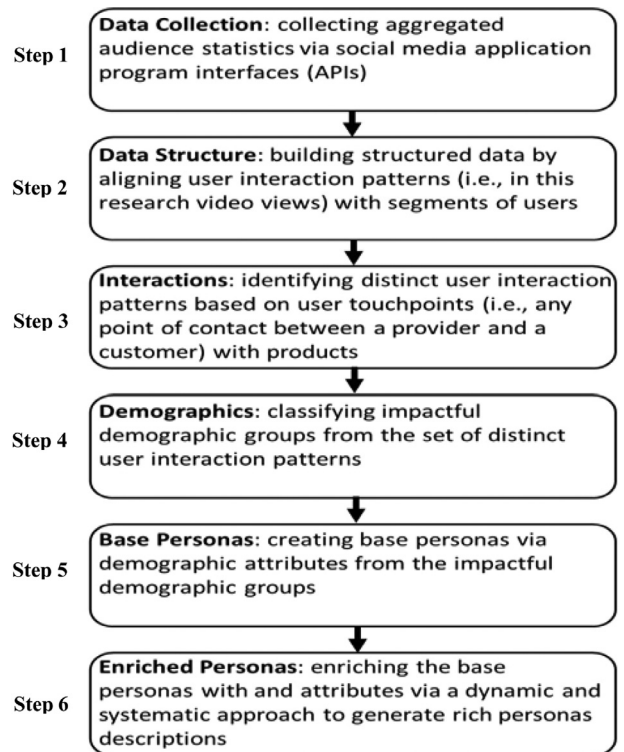


Fig. 3. The APG process of leveraging social analytics data to automatically create the persona profiles.

perceptions of personas profiles by bridging the knowledge gap between the implications multiple photos have and the effect of adding additional photos to 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 causes confusion are less informative.
- H4a and b: [a: contextual, b: attribute-similar] photos are looked at more often than other persona profile content.
- H5 and b: [a: contextual, b: attribute-similar] photos are looked at longer than other persona profile content.
- H6a and b: [a: contextual, b: attribute-similar] photos are looked at more often than headshot photos.
- H7a and b: [a: contextual, b: attribute-similar] photos are looked at longer than headshot photos.
- RQ1: Does the photo incite associations and cultural assumptions ahead 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 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 persona descriptions (Nielsen et al., 2015), as it is assumed; although, we could locate no prior work confirming that contextual photos convey additional relevant information about the persona not also conveyed in a single headshot. Using the photos of multiple people

having the similar key attributes of the personas (*attribute-similar*) but with different non-relevant attributes in an effort to overcome possible biases or stereotyping (Abdelnour-Nocera et al., 2013; Hill et al., 2017) that photo of a single individual might cause. 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 and 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 reveals 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 how more, varied types of photos impact user perception.

In order to answer our research objective, we define two metrics: *informativeness* and *confusion*. We define informativeness as the personal information that is conveyed, which is a definition similar to the concept used in a variety of fields dealing with information transference of Frankel et al. (2006) and Maglio and Campbell (2000). We define confusion as a state of uncertainty concerning the persona. Uncertainty is an increasingly investigated construct (Mitchell et al., 2005) in a variety of fields dealing with end users (Intharah et al., 2017). Several eye-tracking studies have applied a comparable cognitive processing measure (Gwizdka and Cole, 2013; Ouzts et al., 2013). In particular, Blaschek et al. (2016) proposed triangulating eye-tracking data with talk-aloud data. We derive the participants' informativeness and confusion 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 finds 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) and Salminen et al. (2018).

4. Method

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

4.1. 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 et al., 2002).

We had two stations equipped with a desktop computer, the EyeTribe eye-tracking device (Tribe, 2016), and associated software for

Table 1

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

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

logging the sessions. Study participants were digital content creators from major, worldwide news companies. The study took place 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 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 0.5–1° of visual angle. Using a standard participant distance from the screen of approximately 60 cm, the tracker's accuracy corresponds to an on-screen average error of 0.5–1 cm.

There were 30 participants. One session was unusable resulting in 29 useable data recordings, (see Table 1) in the within-subject experimental study. The average participant age 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 in the news industry was seven years, three years of which was with the current company. Their experience with personas varied, with some not that familiar with the concept prior to the study. However, we explained the concept to each participant. 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 using the devices and the procedure.

We showed the three treatments to each participant in a random sequence in order to mitigate order effects (Shaughnessy et al., 2014). The three treatments were persona profiles with similar textual content (see Fig. 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 treatment was denoted by various areas of interests (AOIs), as shown in the example of Fig. 5. An AOI is a denoted subregion of a displayed treatment that permits measuring those sub-region's key indicators. 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.

After completing the IRB consent form, we assigned each participant a unique ID, completed 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

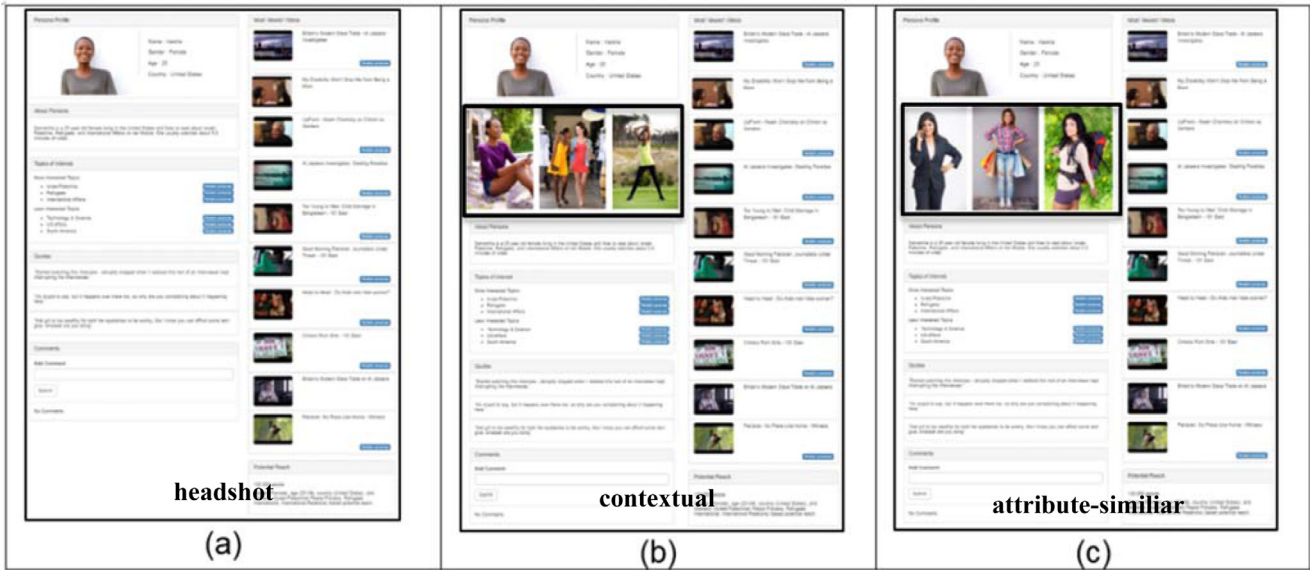


Fig. 4. The three difference persona profiles displayed to the study participants: (a) is the treatment with one headshot photo, (b) is the treatment with the contextual photos (boxed in the figure), and (c) is the treatment with three additional photos of diverse young females (boxed in the figure).

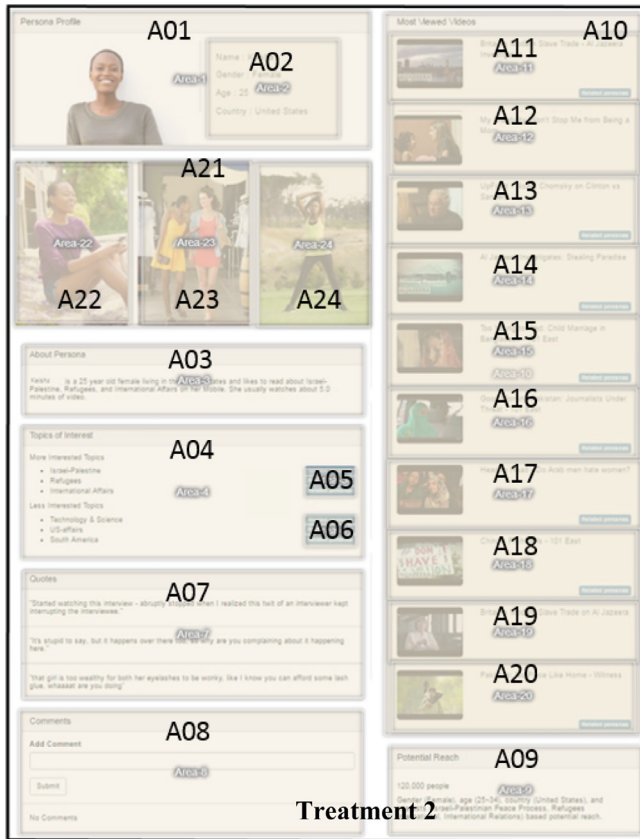


Fig. 5. Treatment 2 (attribute-similar) shown as an example of the AOIs assignments for each of the three treatments. The AOIs allowed us to measure fixation and gaze for key areas of the treatments.

completing the actual tasks. For the actual tasks with three treatments, there were six possible orders. The EyeTribe software can randomly assign the treatments, which we relied on 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 30 min per participant. For each

treatment, we presented the participant with 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 said that he or she was confused, and informativeness was 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). A similar approach of using talk-aloud records to understand users’ mental states was applied in Eger et al. (2007). Fleiss’ Kappa interrater reliability measure indicated satisfactory agreement ($k = 0.71$) (McHugh, 2012).

4.2. 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 origin (e.g., Middle East, Europe, North America). The participants have different roles and work in

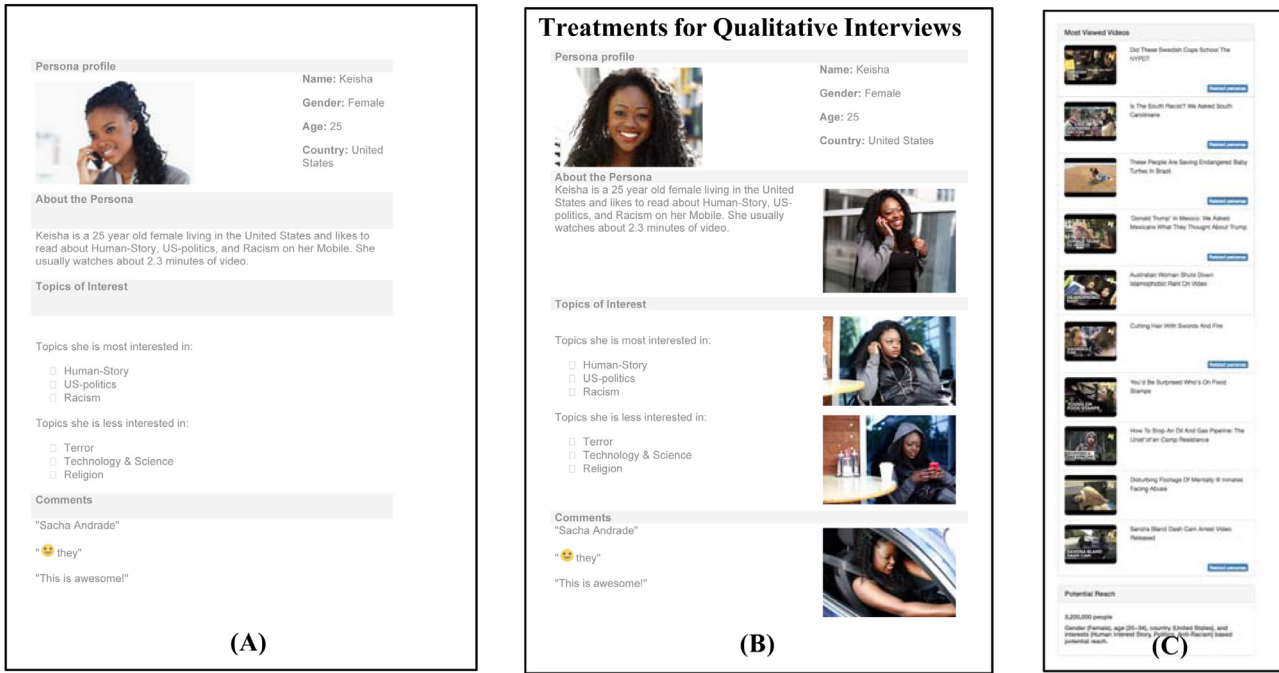


Fig. 6. The two versions of the persona description in Study 2, version (A) without context photos and version (B) with context photos. Followed by a page 2 (C) that is the same for both versions. Each participant was only shown one description.

different parts of the news media network. Half are on the interactive team and work with social media content in roles covering video producer, video editor, additional producer, programmer, and marketing executive. Half work for the website; their roles include 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 Fig. 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 with questions about improvements to the profiles and the overall usefulness of personas as audience representations.

We interviewed each participant for approximately 15–30 min, with each interview subsequently transcribed verbatim. The transcripts were qualitatively coded (Guba and 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 research results, beginning with the eye-tracking and then follow with the qualitative interviews.

5.1. The results of the eye-tracking study

The eye-tracking metrics are shown in Table 2. As expected, T2 contextual and T3 attribute-similar 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 in 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. Based on the analysis, we conjecture that the photos were confusing to follow, so participants did not dwell on them.

The results of the coded confusion and informativeness analysis Tables 3 and 4 summarize the coding results of confusion and informativeness.

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 a contextual photo does not increase 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.

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

Table 2

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

	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)	1501 (9%)	2400 (13%)	2489 (14%)
Fixation duration (s) (% rel. to T1)	6283	6572 (105%)	6303 (100.3%)
Fixation duration on photos only (s) (% rel. to profile overall)	509 (8%)	759 (12%)	728 (12%)

Table 3

Confusion coding for the three treatments.

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

Table 4

Information coding for the three treatments.

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

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.

	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
<i>p</i> -value	NA	0.00060	0.00060

Table 6

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

	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
<i>p</i> -value	0.00043	0.0476	0.1166

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). Fig. 7 illustrates the summarized results.

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

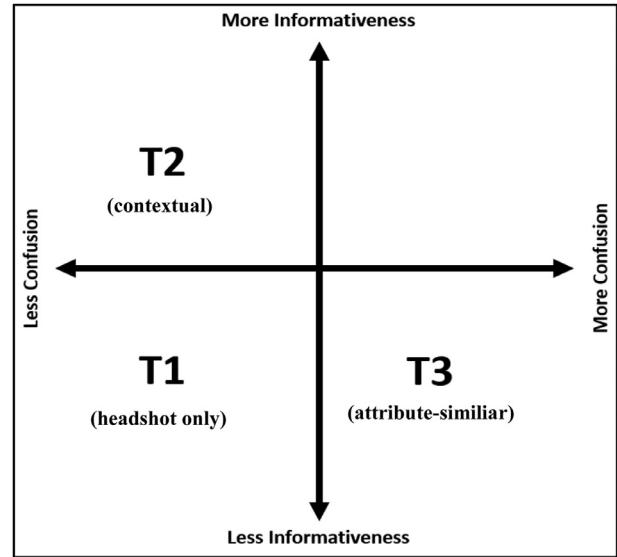


Fig. 7. Informativeness and Confusion among treatments.

TRUE and all others marked FALSE. Finally, this analysis was restricted to T2 contextual and to 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 Fig. 7.

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 on AOIs with contextual photos than those without ($p < 0.0001$). The results of the linear mixed model can be seen in Table 7 and Table 8, showing 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 combined for each participant for each treatment, again excluding T1 headshot. Fig. 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.

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

Table 7

The relationship between contextual photos and number of fixations.

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

Table 8
The relationship between contextual photos and dwell time.

	numDF	denDF	F-value	p-value
(Intercept)	1	613	25,417.692	<.0001
Treatment	2	613	0.165	.8476
CtxtImg	1	613	29.490	<.0001
log(AOI.area)	1	613	148.610	<.0001

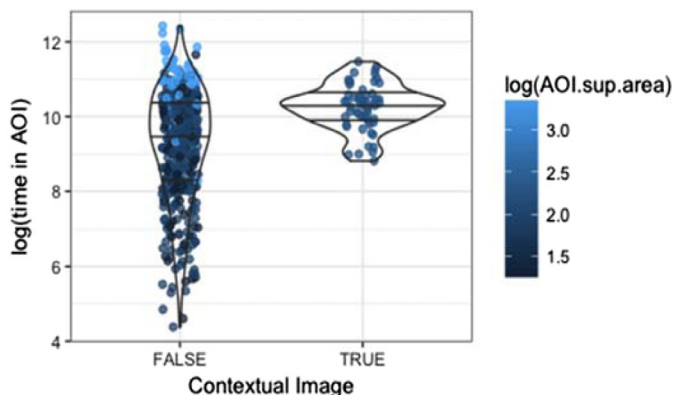


Fig. 8. Time spent in contextual and attribute-similar photos compared to other content. The color coding represents the area – lighter color indicates larger areas, so one can see that (for non-contextual photos at least), the larger areas had longer total durations.

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

	numDF	denDF	F-value	p-value
(Intercept)	1	249	960.9925	<.0001
Treatment	1	249	0.3705	.5433
CtxtImg	1	249	1.7139	.1917
log(AOI.area)	1	249	125.4173	<.0001

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 by the small number of fixations on AOI 21. The results are shown in [Table 9](#).

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 being 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 [Fig. 9](#) and [Table 10](#).

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 spent significantly more time focused on contextual photos ($p < 0.0001$), as shown in [Table 11](#).

So, H7a and H7b are fully supported; the use of contextual and attribute-similar photos attract more fixations than a headshot photo. [Fig. 10](#) shows the dwell times. [Fig. 11](#) is a bump plot where each line represents a participant. The majority of the lines show a positive slope, representing the longer duration spent on contextual and on attribute-similar photos compared to the headshot photo.

We also tested the difference between attribute-similar and non-attribute-similar photos. This only includes T2 and T3, and only compares the contextual photos (i.e., AOIs 21–24). As before, the Super

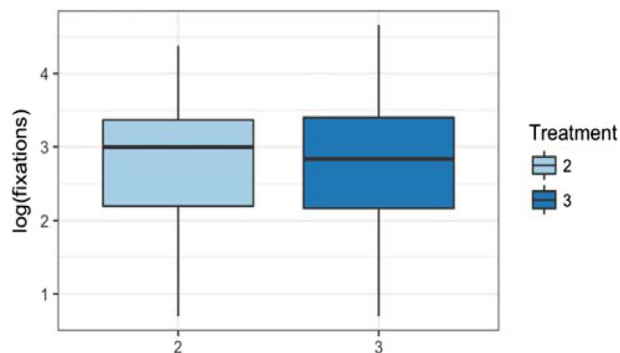


Fig. 9. Comparison of the total number of fixations between T2 contextual and T3 attribute-similar. This analysis only considered the contextual and attribute-similar photos.

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

	numDF	denDF	F-value	p-value
(Intercept)	1	192	937.2101	<.0001
Treatment	1	192	1.2576	.2635
log(AOI.emb.area)	1	192	120.0946	<.0001

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

	numDF	denDF	F-value	p-value
(Intercept)	1	85	10,577.818	<.0001
Treatment	1	85	0.475	.4925
CtxtImg	1	85	65.958	<.0001

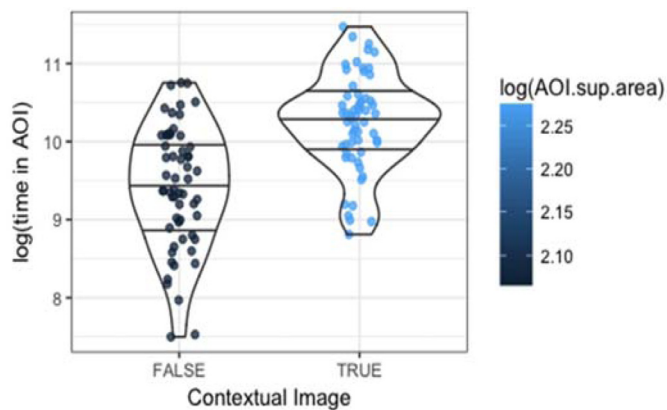


Fig. 10. Dwell times in contextual and attribute-similar photos (TRUE) compared to headshot photo (FALSE). The results show a tendency to spend more time on contextual photos.

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 [Fig. 12](#). There was no difference in the total duration of contextual photos in T2 versus T3. Because there was only one Super AOI included, this area was not evaluated.

6. Results of the qualitative interviews study

We report the results of the qualitative interviews based on the data analysis to address RQ1. In total, the qualitative interview transcripts contained 17,784 words and 1933 unique words for a vocabulary density of 0.109. [Table 12](#) shows the top ten most frequently occurring

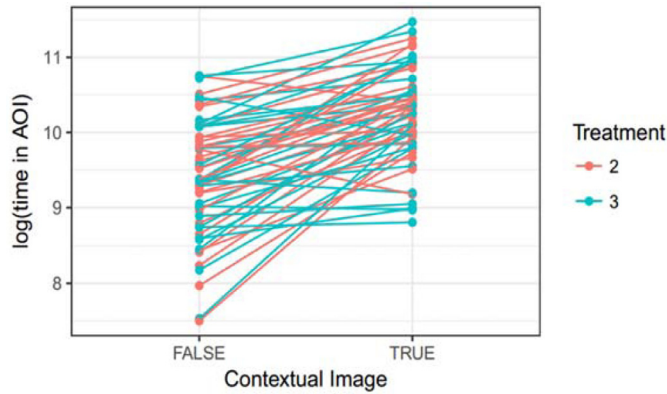


Fig. 11. Dwell times in contextual and attribute-similar photos compared to static photos. Each line represents an individual participant. There is variation among individuals, but, generally, each person spends more time looking at the contextual and attribute-similar photos.

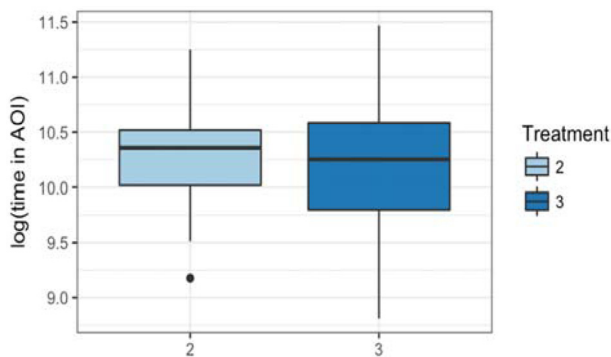


Fig. 12. Comparison of total duration of fixations between T2 and T3. This analysis only considered the contextual and attribute-similar photos.

Table 12
List of top terms (All and Content) from qualitative interviews.

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%

terms and the top ten most frequently occurring terms with stop words removed.

7. 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 Fig. 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 racism 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 20 s 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 Fig. 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 attacks 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 their understanding of the persona's interest in racism on the photo; they then add their own cultural knowledge of African-Americans to create the story of a culturally aware person. This tells us that the photo incites 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 confirm 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...

8. Contextual photos

The contextual photos seemingly support the textual information, which may relate to the prior work in the use of peripheral information (Maglio and Campbell, 2000). This is demonstrated 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 (Fig. 6A) and those with (Fig. 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...

9. Richness of information

Though 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 US 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, supplementing the narrative may occur with other types of personas also.

10. 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 images are helpful in persona profiles and if they help alleviate 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 the contextual photos seemingly support cultural assumptions and simplistic explanations for the persona's interest in, for example, racism.

Indeed, our thought-provoking findings pertain to the experiences participants project on the persona photos they see 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 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 persona's circumstances. This end user projection can be understood as an inherent psychological trait of human cognition (Machover, 1949), and it is not realistic 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 data that serves as the basis for the persona's *group* diversity.

In terms of effort to process the additional photos, we set out to find how manipulating persona profile photos influence 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 viewed longer than other content and 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 looked at longer

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 to measure 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 interest level. In line with their findings, we thus expect that if the additional photo content drives attention, it is also perceived as 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 gained from additional visual elements results in additional cognitive costs that exceed marginal information benefits. Since the layout of the persona system is readily available for modification, it is possible to experiment with different data representation layouts by altering the persona profile elements in future studies.

As they pertain 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 demonstrates that informativeness increases with contextual photos. On the other hand, it becomes difficult, perhaps impossible, to control the persona's interpretation, 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 unintended attributes. 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 use a more formalized measure for informativeness such as information intake (Gwizdka and Cole, 2013), in addition to 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) using complementing data sources such as click maps to better understand users' visual interaction with the system; (b) recording user behavior with a live system instead of with static layout photos; and (c) increasing 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 disagreement among the coders. More specific measures could be used in future work. Fourth, by leveraging a more nuanced implementation of additional studies, we 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 to better understand how users visually interact with online personas.

In conclusion, we postulate a tradeoff exists among informativeness, confusion, and perceptual bias when increasing the number of information elements in persona profiles, and for 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 developing 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 the persona profile's informative content.

11. 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 are oftentimes more compelling to both unsophisticated and sophisticated end users alike. Given the generally known information processing limitations of web layouts, the determination of the boundaries of persona representation forms a relevant research problem. We establish that photo content is a strong attention driver that 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 can apply in their professional tasks. For example, content creators in the media company use 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 adding contextual photos potentially increases informativeness without negative consequences.

However, it is essential to carefully choose photos because images become 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 completing 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 persona.

This research represents an initial step toward defining 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 valuable 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 persona's circumstances. 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 persona creators 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 designer's influence on persona profile's information content. 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 that the persona is based on. With such actions, we can begin evolving toward more rigorous research into persona profiles design, including synergistically mixing headshot pictures, contextual photos, and supporting textual information.

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