

Singapore Management University

Institutional Knowledge at Singapore Management University

Research Collection School Of Computing and
Information Systems

School of Computing and Information Systems

4-2018

'Is more better?': Impact of multiple photos on perception of persona profiles

Joni SALMINEN

Hamad Bin Khalifa University

Lene NIELSEN

Soon-Gyo JUNG

Jisun AN

Singapore Management University, jisunan@smu.edu.sg

Haewoon KWAK

Singapore Management University, hkwak@smu.edu.sg

See next page for additional authors

Follow this and additional works at: https://ink.library.smu.edu.sg/sis_research



Part of the [Databases and Information Systems Commons](#), and the [Graphics and Human Computer Interfaces Commons](#)

Citation

SALMINEN, Joni; NIELSEN, Lene; JUNG, Soon-Gyo; AN, Jisun; KWAK, Haewoon; and JANSEN, Bernard J.. 'Is more better?': Impact of multiple photos on perception of persona profiles. (2018). *CHI '18: Proceedings of the CHI Conference on Human Factors in Computing Systems, Montreal, April 21-26*. 1-13. Available at: https://ink.library.smu.edu.sg/sis_research/6535

This Conference Proceeding Article is brought to you for free and open access by the School of Computing and Information Systems at Institutional Knowledge at Singapore Management University. It has been accepted for inclusion in Research Collection School Of Computing and Information Systems by an authorized administrator of Institutional Knowledge at Singapore Management University. For more information, please email cherylids@smu.edu.sg.

Author

Joni SALMINEN, Lene NIELSEN, Soon-Gyo JUNG, Jisun AN, Haewoon KWAK, and Bernard J. JANSEN

“Is More Better?": Impact of Multiple Photos on Perception of Persona Profiles

Joni Salminen

Qatar Computing Research
Institute,
Hamad Bin Khalifa University;
and Turku School of Economics
Doha, Qatar
jsalminen@hbku.edu.qa

Lene Nielsen

IT University of Copenhagen
Copenhagen, Denmark
lene@itu.dk

Soon-gyo Jung

Qatar Computing Research
Institute,
Hamad Bin Khalifa University
Doha, Qatar
sjung@hbku.edu.qa

Jisun An

Qatar Computing Research
Institute,
Hamad Bin Khalifa University
Doha, Qatar
Jisun.an@acm.org

Haewoon Kwak

Qatar Computing Research
Institute,
Hamad Bin Khalifa University
Doha, Qatar
haewoon@acm.org

Bernard J. Jansen

Qatar Computing Research
Institute,
Hamad Bin Khalifa University
Doha, Qatar
bjansen@hbku.edu.qa

ABSTRACT

In this research, we investigate if and how more photos than a single headshot can heighten the level of information provided by persona profiles. We conduct eye-tracking experiments and qualitative interviews with variations in the photos: a single headshot, a headshot and images of the persona in different contexts, and a headshot with pictures of different people representing key persona attributes. The results show that more contextual photos significantly improve the information end users derive from a persona profile; however, showing images of different people creates confusion and lowers the informativeness. Moreover, we discover that choice of pictures results in various interpretations of the persona that are biased by the end users' experiences and preconceptions. The results imply that persona creators should consider the design power of photos when creating persona profiles.

Author Keywords

personas; user perceptions; online data representations

ACM Classification Keywords

H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces; K.4.m. Computers and society: Miscellaneous

INTRODUCTION

Personas have been widely used for years in computer science and in other fields [10]. Despite their popularity, it is

difficult to decide how to best create personas [25, 44, 62]. Over the years, a common layout of the persona profile has been developed [56] that includes a short, 1-2 page textual description and a photo, most often a headshot or a drawing, with Figure 1 representing a typical layout.



Figure 1. Typical, non-automated, persona description [53].

Few studies have systematically examined different layout options for personas. De Voil [11, p. 3] even argues that “there is no rigorous or even rational basis for the selection of details to attribute to the persona.” In this research, we address this argument by experimentally studying different layouts with the purpose of determining which layouts are more optimal than others.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from Permissions@acm.org.

CHI 2018, April 21–26, 2018, Montreal, QC, Canada

© 2018 Association for Computing Machinery.

ACM ISBN 978-1-4503-5620-6/18/04...\$15.00

<https://doi.org/10.1145/3173574.3173891>

In particular, the effect of the photos has not been widely researched, and to our knowledge, no one has looked into the effects and possible issues the photo might pose when shown to end users, especially in design and work groups with an international, interdisciplinary, and cross-cultural set of end users. A photo depicts a specific nationality, ethnicity, and race that can be difficult to align with a culturally diverse pool of end users [55]. While one photo has the advantage of not introducing non-relevant information, a single photo can also interject biases into the interpretation of the persona and carry cultural assumptions, as end users may associate stereotypical attributes with the photo.

In this research, we explicitly investigate this tension through an approach to personas that includes multiple photos for a single persona in two different avenues: (a) multiple photos of the same person in different contextual situations, in this case, the persona seen in work and leisure situations; and (b) multiple photos of different persons but all with the persona's properties that are particularly noticeable in photos, such as gender, ethnicity, and approximate age. We compared these two approaches to an identical persona with only one headshot photo using a controlled laboratory eye tracking study and in-depth interviews of digital content creators whose job goals include reaching a global audience.

This research is important to the field, as the persona profiles are typically the major end product in the persona development process. Although personas have claimed benefits in the design process [2, 5, 12, 13, 17, 20, 23, 27, 36, 45, 48, 63, 65], the procedure of creating personas is typically not viewed as affordable, easy, or quick [13]. Therefore, getting the end product (i.e., the persona profile) as 'right' as possible is critical to the applicability and usefulness of personas in real decision-making situations by the organizations relying on personas as a source of audience, user, or customer insight.

Additionally, with automatic persona generation (APG) [3, 37, 39], determining the optimal information content, the best layout, and the value of the photo becomes important because it is easy to manipulate and to personalize the information elements and arrangement according to particular users' real-time needs or preferences. In related work, where we have 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) [3, 37, 39, 49], we have observed this challenge. For that reason, a general understanding of persona profiles is essential. In this research, through a series of user studies, we suggest better persona profiles in terms of more informativeness and of less confusion. These results can potentially have an impact on improving data-driven persona generation, while also informing the design of persona profiles using the traditional approaches.

RESEARCH QUESTION AND HYPOTHESES

To bridge the knowledge gap between the implications of images in connection with persona profiles' textual information, we are interested in knowing how different pictures influence the users' perceptions of personas profiles. In particular, we formulate the following hypotheses (H) and research question (RQ):

- H1a and b: *Adding [a: contextual, b: attribute-similar] images increases the perceived confusion relative to a headshot image.*
- H2a and b: *Adding [a: contextual, b: attribute-similar] images increases the perceived informativeness relative to a headshot image.*
- H3: *Image changes to the persona profile that cause confusion result in lower informativeness.*
- RQ1: *Does the photo incite associations and cultural assumptions on top of the written information?*

Our foundation for evaluating these three persona profiles is that one photo (typically a *headshot*) is a standard practice in persona profiles [54]. The use of *contextual* photos is also not uncommon in personas descriptions [56], as it is assumed; although we could locate no prior works validating this, that contextual photos convey additional valuable information about the personas that a single headshot photo does not.

Using the photos of multiple people that all have the key attributes of the personas (*attribute-similar*) but were different in other attributes is an effort to overcome any biases or stereotyping [1, 30] engendered by a photo of a single individual. The concept of Mien Shiang [8], i.e., Chinese face reading, for example, is based on the concept that a face can convey certain characteristics, such as emotion and expression [32]. So, it is a reasonable assumption that a single photo, especially when a headshot, would engender certain stereotypes that we might want to avoid in the persona, as they divert the user's attention from other information elements, such as topics of interest.

To answer our research questions, we first define two metrics: *informativeness* and *confusion*. We define informativeness as the conveyance of information, in this case, concerning the persona, which is similar to the concept used in a variety of fields dealing with the transference of information [19, 43]. We define confusion as a state of uncertainty, again, in this case, concerning the persona. Uncertainty is an increasingly investigated construct [50] in a variety of fields dealing with end users [33]. Several eye tracking studies have applied comparable measures of cognitive processing [28, 59]. In particular, Blaschek et al. [6] 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 [30].

To answer our research question and hypotheses, we conduct two related 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 APG system [37], which is a system for automatic persona generation from online social analytics data.

RELATED WORK

The following section reviews key prior works on persona content, its implications for cross-cultural teamwork, and use of automation to generate persona profiles.

Related work on persona content

The written content of a persona profile has been studied by few authors [18, 38, 56]; these studies point to persona profiles including 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. The studies have only looked at the textual information and do not include investigation concerning the accompanying profile photo. Two prior studies have looked into if illustrations make personas memorable [41, 57] with conflicting conclusions related to the question of if drawings are better than photos.

To our knowledge, only one study has examined whether more photos are better than one for the end users [30]; this study focused on gender stereotyping, finding additional photos did not affect end user stereotyping. However, Jensen et al. [34] conclude that while photos enable identification and empathy and support recall of personas, they also seem to support (or provoke) ethnicity and gender stereotypes. Thus, very little research has gone into the presentation of the persona profile's information and even less research has gone into the impact of the photos and of photo selection on the interpretation of personas by the end users.

Related work on personas formed from quantitative data

Even though the most prevailing methods for data collection for personas have been qualitative in nature [2, 10], the collection and use of quantitative data have been suggested by several authors [7, 40, 46, 49, 68]. For example, Brickey, Walczak, and Burgess [7] conclude that a method based on principal component analysis (PCA) outperforms Latent Semantic Analysis (LSA) and Multivariate Cluster Analysis (MCA) for persona clustering, while Laporte, Slegers, and De Grooff [40] suggest using multiple correspondence analysis to create persona segmentations.

Related work on personas in cross-cultural projects

The cultural aspect of personas is not clearly defined, and organizations only recently started to consider the possibility of developing personas for global markets [66]; there is very little information on how to account for cultural differences when creating personas [69]. Snyder et al. [69] discuss three approaches to integrating cultural differences into persona

descriptions: (a) a separate persona for each culture and for each task; (b) U.S.-based persona descriptions, each including sections with cultural differences; and (c) one persona from each country with the cultural differences as part of the descriptions. In this particular case, the team realized that there were few cultural differences [69]. They ended up with persona descriptions from several countries, as a reminder to the team that the product is used in different countries and cultures.

Using personas beyond the WEIRD (Western, Educated, Industrialized, Rich, and Democratic) [70] parts of the world, Putnam et al. [64] describe two cases of conveying data for personas from Kyrgyzstan and the Andhra Pradesh region of India. One of the strategies was to use scenarios in the persona profiles to convey cultural and lifestyle differences. Cabrero et al. [9] advocates for co-designing personas with end users to overcome over-simplistic cultural assumptions. Jensen et al. [34] suggest practice theory for an understanding of culture and enabling designers to forget about national borders. Hill et al. [30] attempt 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.

The issue of developing personas for cross-cultural teams is acutely important for work both with the APG system and with traditionally developed persona profiles, as many potential user organizations are extremely 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 across team members. In the following, we will describe the APG persona profiles.

APG persona profiles

The persona profiles from the APG system are based on social media data retrieved via the API of popular social media platforms such as Facebook and YouTube. The data retrieved focuses on both content interaction and demographic attributes. Content interaction describes how users have viewed, liked, or shared content (e.g., videos, posts), while the demographic data includes age group, gender, and location [31]. Because this data is not publicly available but can only be accessed by the account holders, the system uses an organization's API keys to retrieve the data and store it into a local PostgreSQL database for further processing. The major strength of this automated approach is that it benefits from real user data, reducing time and cost for generating behavioral and demographic user segments, and providing a mechanism for linking the two types of segments into a holistic persona profile.

The APG persona profiles (see Figure 2) have much less published prior work than the consensus [4, 16, 22, 29, 35, 51, 52, 54, 60-62] concerning persona presentations suggests. The personas profiles from the APG system

include demographic information, information about interests, and information about usage patterns (e.g., the 10 most viewed videos). The persona profile is enriched with social media quotes [73] derived from real users in the corresponding behavioral segment. See published prior work for an in-depth discussion of the APG system [3, 37, 39].

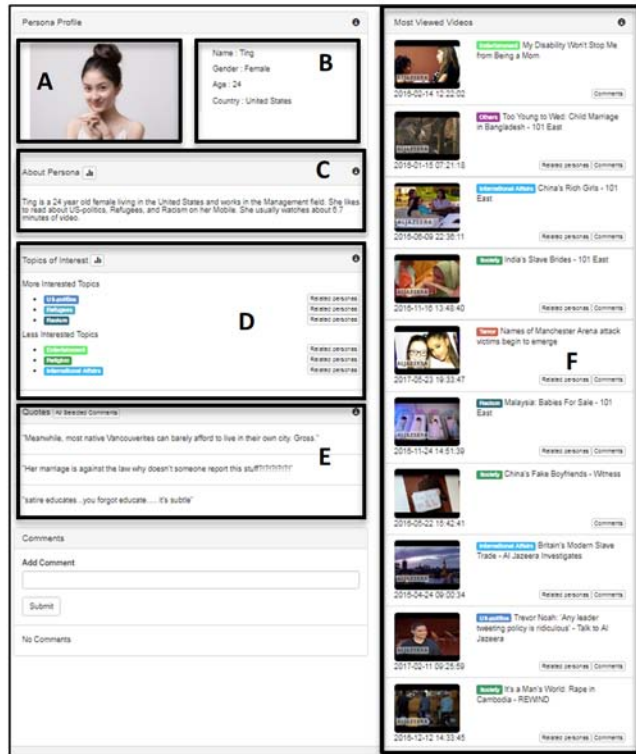


Figure 2. Example of an automated persona profile.

The APG creates the persona profile by automatically adding pertinent features, such as name, photo, and personal attributes (see Figure 2). Careful thought has gone into the photo selection: for example, we purchased copyrights to more than 4,000 commercial stock photos of models for different ethnicities, genders, ages, and cultural identities. The selection of different styles to represent different professions, interests, etc. can strengthen the expressive power of the persona, so we have selected varied photos for each demographic group and tagged each photo with the appropriate metadata. Then, through age group, gender, ethnicity, country, etc. of a representative user segment, the system assigns an appropriate photo to a persona. The photos are headshot-style photos, as can be seen from Figure 2. The APG methodology consists of six steps, shown in Figure 3.

The APG persona descriptions are divided into six sections: persona profile that presents name, age, gender, and country (B in Figure 2), along with a photo (A). This is further described in the section ‘About persona’ (C). The topics of interest (D) are then presented as bullet points. The three last sections include: ‘Quotes’ 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 from Facebook Marketing API with the corresponding targeting criteria (not visible in Figure 2).

Overall, the APG personas have less background information on personality, psychographics, and lifestyle information than is typical for traditionally-created personas (compare Figures 1 and 2), but they provide more detailed and accurate descriptions on user interest, interaction patterns, etc. Because automated personas tend to have less textual data [3], the photos carry a larger importance for conveying information to end users concerning the personas.

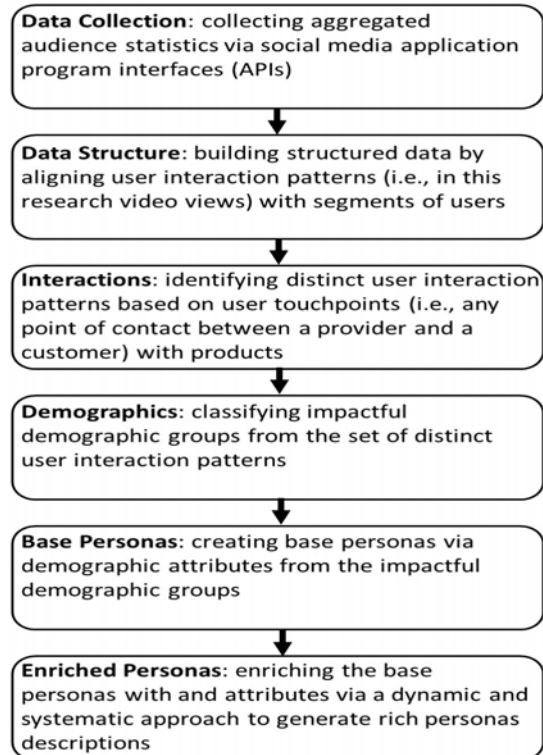


Figure 3. The process of converting social analytics data automatically into persona profile.

METHODS

As mentioned, we aim to gather two types of feedback from the participants. Explicit feedback is gathered from the interviews and captures the opinions of the participants, while implicit feedback is collected through eye tracking that captures the visual attention given by the participants to different information elements in the persona profiles. The following sections explain these approaches.

Study 1: Eye-tracking

We applied eye tracking as a method to answer our research questions. Eye tracking is widely used to study website usability both for prototypes and ready products [14]. It can be used to reveal interaction patterns toward navigational and content elements and to provide design recommendations for system development [21].

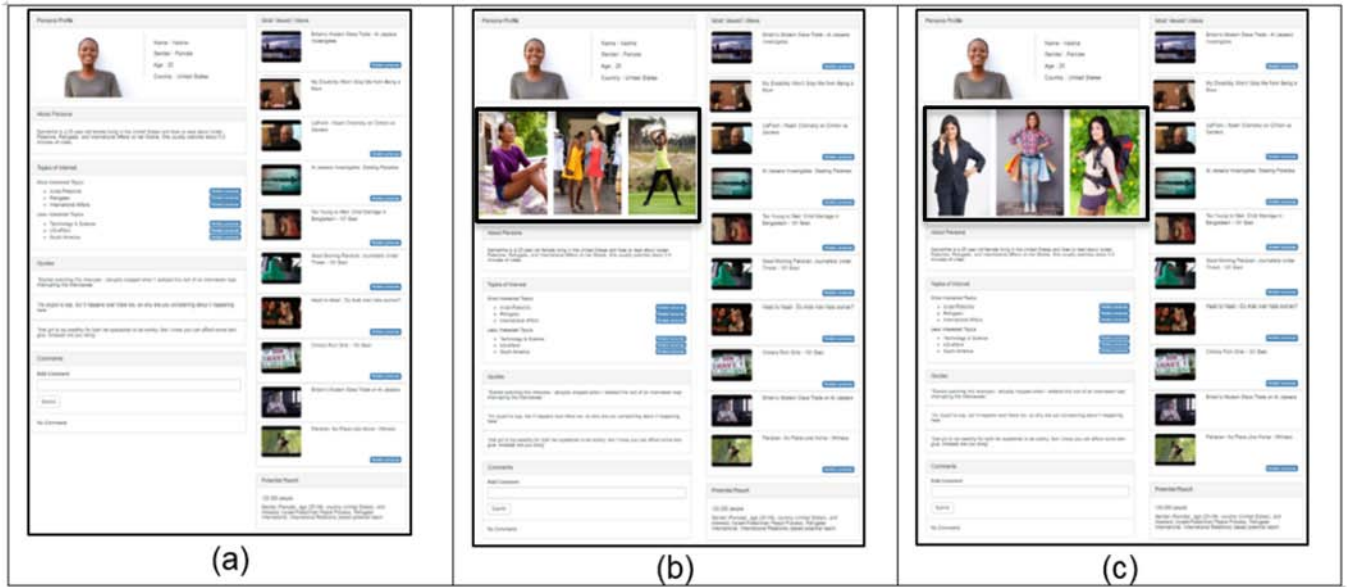


Figure 4. The three difference persona descriptions are shown to the study participants in study 1. (a) is the treatment with one headshot photo. (b) is the treatment with the contextual photos (highlighted in the figure). (c) is the treatment with three additional photos of diverse young females (highlighted 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 Study 1. Participants of the role ‘Other’, include executive, computer programmer, analyst, and marketer.

We had two stations, each equipped with a desktop computer, the EyeTribe eye-tracking device [72], and associated software for logging the events. Our participants for this study were digital content creators from a major, worldwide news organization (Al Jazeera English).

There were 30 participants, with 29 useable data recordings, (see Table 1) in the within-subject experimental study. The average age of participants was 33-years-old. The participants were selected to reflect the staff working with news content on a daily basis and formed a diverse pool of individuals originating from 19 different countries (e.g., Egypt, Georgia, Germany, Syria, UK, USA, etc.). Producers are the primary content creators of news articles and videos both for web and television, whereas editors prepare the content for final publication, mainly for social media

channels. The average experience of participants in the news industry was seven years and three years in the current company. Their experience with personas varied so that some were not that familiar with the concept prior to the study. However, each participant was explained the concept. The reason for choosing these participants was that the authors are developing an automatic persona generation system for their organization. They are thus end users of the persona profiles. The participants were not financially compensated for taking part in the study. We instructed all participants in the same way at the beginning of the experiment about the usage of the devices and the procedure.

Each participant was shown three treatments (see Figure 4). The treatments were shown in a random sequence to each participant in order to mitigate order effects [67]. The three treatments were persona profiles with similar textual content (see Figure 4):

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

Each of the persona profile treatments was denoted into various areas of interests (AOIs), as shown in the example of Figure 5. An AOI is a selected subregion of a displayed treatment permitting the measuring of key indicators only for those sub-regions. To begin 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 about the study.



Figure 5. Example of the AOIs assigned for each of the three treatments (Treatment 2 shown as an example). The AOIs permitted us to measure fixations and gaze for key areas of the treatments.

After completing an IRB consent form, we assigned each participant a unique ID and had the participant complete a short demographic survey. We then calibrated the eye-tracking device. Each participant first 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 used for counterbalancing. An equal number of participants doing each of the six experiments ensures all factors are counterbalanced, thus eliminating any ordering effects.

For each treatment, we read 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 journalist was interested in writing:

“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.”

The entire user study took approximately thirty minutes per participant.

Three researchers independently coded confusion and informativeness for each participant and treatment (P-T pair). According to the principles of cognitive discourse analysis (CDA) [71], we used participants’ explicit cue words such as “confusing,” “did not understand,” and “difficult to say” to label 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 therefore 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 a disagreement for a given P-T, we used majority voting to determine whether the instance was informative/confused. 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 e.g. in [15]. The interrater reliability measure, Fleiss’ Kappa, indicated satisfactory agreement ($k=0.71$) [47].

Study 2: Qualitative Interviews

To understand in depth the participants’ perceptions of the photos in connection with the written information and to investigate if the photos carry information that supplements the textual information, we conducted 16 qualitative interviews with participants from the company in Study 2.

Like 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. Eight of them work in the interactive team with social media content in roles covering video producer, video editor, additional producer, programmer, and marketing executive. Another eight work for the website, their roles including feature editor, opinion editor, journalist, translator, documentarist, and web analyst. The interviews were conducted after the eye tracking sessions. All of the interview participants also participated in the eye tracking study, but not *vice versa*. This is because not everyone had time for both studies.

The participants were asked about their job role, tasks, and how long they had worked in the organization. Then, they were asked, “Who is a typical Al Jazeera reader/viewer?” After this, they were shown one of the two persona profiles (see Figure 6) 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

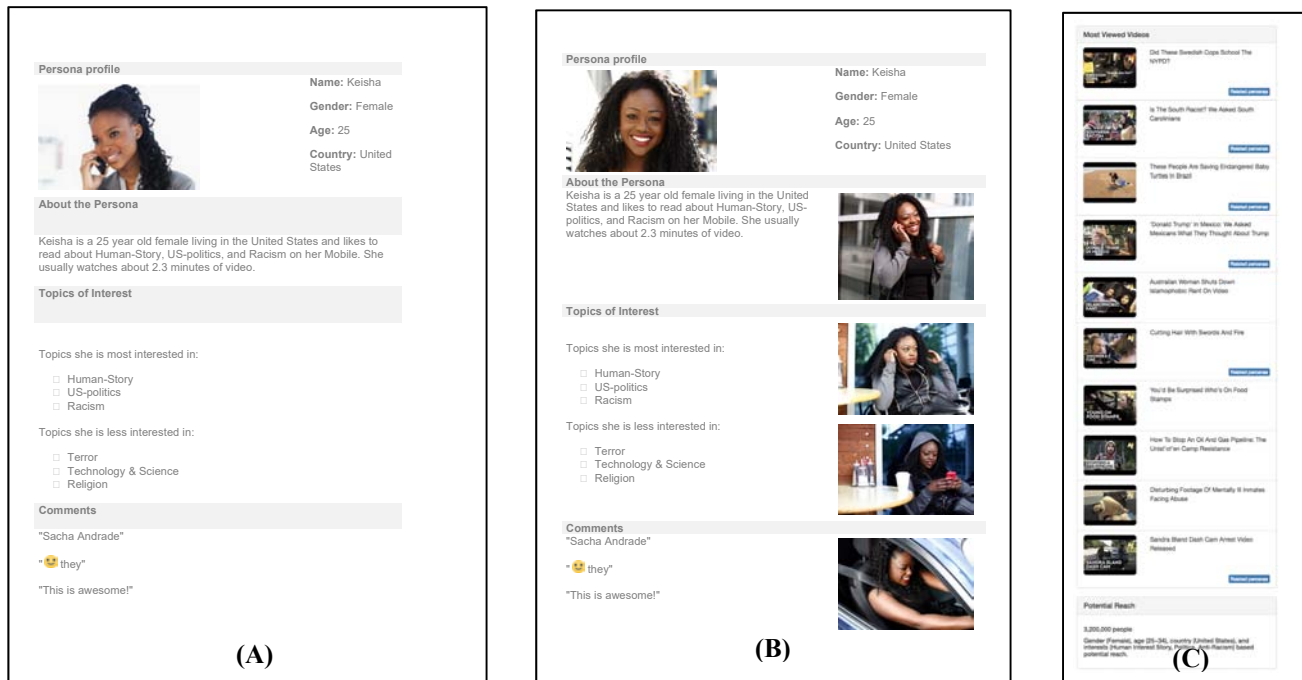


Figure 6. The two versions of the persona description in Study 2, version (A) without context photos and version (B) with context photos. Followed by a page 2 (C) that is the same for both versions. Each participant was only shown one description.

study. The interview ended in questions about improvements to the profiles and the overall usefulness of personas as audience representations.

Each participant was interviewed for approximately 15–30 minutes, and each interview was subsequently transcribed verbatim. The transcripts were qualitatively coded [26] and from this, a number of themes were identified, such as persona description, most important information, evaluation of information, usefulness, photos, context, and platform use.

RESULTS

Here, we report the results of our research, beginning with the eye-tracking study and then following with the qualitative interviews.

The results of the eye-tracking study

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

Although 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 2, contextual images bring a 13–14% increase in the number of fixations. The duration is similar for T2 photos, but the increase for T3 photos is quite small. We conjecture, based on analysis to follow, that the photos were confusing, so participants did not dwell on them.

	T1	T2	T3
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 treatments, overall and for photos. Treatments with contextual images get more attention.

The results of the coded confusion and informativeness analysis

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

	T1	T2	T3
No confusion	29	29	14
Confusion	0	0	15

Table 3. Confusion coding among the three treatments.

	T1	T2	T3
No informativeness	28	10	19
Informativeness	1	19	10

Table 4. Information coding among the three treatments.

To examine H1a and H1b, we tested the effect of Treatment (T1, T2, and T3) on confusion. We performed the Cochran's Q test, which is like a repeated-measure ANOVA for handling dichotomous responses. The result showed a significant effect between treatment and confusion (Chi-Square=30, df=2, $p=3.059e-07$). We then performed the McNemar's post-hoc test on each pair of treatments to isolate the effect. The results are presented in Table 5. We note that no participants reported confusion on T1 and T2.

Thus, we have a significant difference of confusion between T1 (T2) and T3 ($p=0.001$). In other words, showing the multiple attribute-similar photos has a statistically significant impact on confusion. Thus, H1b is supported, but H1a is not: *adding attribute-similar images increases the perceived confusion relative to a headshot image but adding contextual image does not increase confusion.*

	T1-T2	T1-T3	T2-T3
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 under T1 and T2 are identical with zero confusion.

Next, we tested the effect of treatment on informativeness to test H2a and H2b. We performed the Cochran's Q test. Again, we found a significant effect of treatment on informativeness (Chi-Squared=21.13, df=2, $p=2.58e-05$). We then performed the McNemar's post-hoc test on each pair of treatments to isolate the effect (see Table 6).

	T1-T2	T1-T3	T2-T3
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 pair of treatments. The p-values are Bonferroni corrected.

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

Finally, we used 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 found that T1 has the highest number of participants with 'No confusion & No informativeness', T2 has the highest number of participants with 'No confusion & informativeness', and T3 has the highest number of participants with 'Confusion & No informativeness'. Following these frequencies, 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.

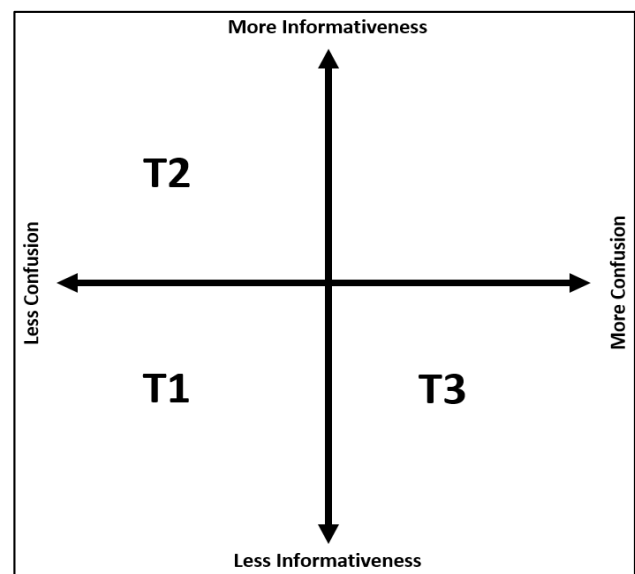


Figure 7. Informativeness and Confusion among treatments.

Result 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.

Relating to the persona as an Individual human being

Asked if the participants know someone who is like the persona (see Figure 6A), nearly all have met a similar person at university or through colleagues, friends, or family, upon which they base the familiarity via gender, age and interests. Interestingly, three 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) *“...,but I know a handful of African-American women in the U.S. that are roughly my age and who were interested in these things.”*

(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 any persons resembling the persona, and one has briefly met someone but does not have any acquaintances that resemble the persona.

The written 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.

(P11, version A) *“I would say her search and her interests are based on who she is and how she was raised by previous generations, what they educated her in of their growing up. This has obviously peaked her interest in race stories; she is into black American politics because we are seeing how politics are going in U.S. and both of those facets feed into human stories. So, she is an empathetic culturally aware person that is aware of her own identity who she is in the general scheme of things.”*

(P10, version A) *“I’m not sure if I should say this, but you know, as an African-American, it seems intuitive that she would be interested in racism because it affects her on a daily basis.”*

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.

Contextual photos

The contextual photos seem to support the textual information, which may relate to the prior work in the use of peripheral information [43]. 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 P10 extrapolate on her behavior.

(P10, version B) *“I think she’s, she might be, based on the very short number of minutes that she views. She might be one of these persons that just reads the headline and clicks “like”. Without going into depth, into it. Which is annoying. And “this is awesome” comments sort of seem to indicate that she’s a person who would also share it as well. She’s very active on her phone so she’s probably sharing.”*

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.

(P6, version B) *“She is interacting with some kind of media almost all times. I assume she is listening to the radio or something in the car. Here she is either on Facebook watching Al Jazeera; here she is talking with a friend about the video she just watched. She looks like a typical young person that is interacting with media at all times.”*

(P8, version B) *“She has a lot of free time (laughing). She’s not a mum neither working - definitely. She likes to use her mobile, not a careful driver.”*

The quote below shows how the participant is trying to interpret the photos into the context of news consumption.

(P10, version B) *“Yeah. There’s only one where she’s actually, her eyes are on the screen. So, I mean in this one she’s on the phone so she’s listening; this one’s she, I mean, she’s got her fingers on the phone so she might actually be texting. This one she is driving, so I’m not sure whether she’s, whether it’s relevant or not. So none of them - it shows that she’s on the move - that’s she’s using quite a lot of her phone when she’s on the move, but whether she is consuming content on the move, I’m not sure.”*

Richness of Information

Even 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 of them expressed wishes for more information. The information that the participants’ request can be divided into three categories:

- **Background information** that helps the user understand the persona: education, job, where in the U.S. she lives, etc.
- **Peripheral information** that helps 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** about the data sources, how representative is the description, explaining definitions

Since automatically generated personas do not currently include this level of information, the informants, 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.

CONCLUSION AND DISCUSSION

This study represents a step toward defining the right 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 research goal was to investigate if more photos are helpful in persona profiles, which would assist in alleviating the terse textual data in automatically generated persona profiles. The quantitative analysis shows that having more contextual photos significantly improves the information end users get from a persona profile. However, showing images of different but similar people creates confusion and may lower the informativeness. Moreover, from the qualitative analysis, we discover 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 interesting findings relate to projections by participants of their experiences to the personas on the basis of photos they are seeing. While being more informative, photos are subject to interpretations. The cross-cultural pool of participants exhibits the diversity properly associated with the use of images; some had first-hand experience in racism, while others expressed sympathy for the African-American persona. We postulate that *as the diversity of the user base increases, so does the number of mixed interpretations of ambiguous persona information*, e.g. pictures. However, as noted in [72], more work on the impact of culture on persona perception is needed, and we acknowledge that our work is only a starting point.

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 can be understood as an inherent psychological trait of human cognition [42], and it is not realistic to assume changing 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 individuals and algorithms when selecting information content for persona profiles. We suggest two solutions: (a) mitigating bias-inducing information content as much as possible, or (b) adding another layer of information that enables the user to better understand the diversity of the data of the *group* the persona is based on.

Relating to prior work, we find that our findings have implications for persona descriptions, especially on the lighter-weight variations, such as ad-hoc personas and proto-personas [24, 58]. We also confirm the premise investigated by Hill et al. [30] that is related to the picture choice affecting how end users interpret personas. While Hill et al. [30] 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 question “is using more photos better than one photo?” we answer “yes and no”. On one hand, the analysis shows that informativeness increases with contextual photos. On the other hand, it becomes hard or impossible to control the interpretation of the persona, and thus that of the underlying data, as shown by the qualitative analysis. As we observed, 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.

Regarding limitations, we report the following. First, informativeness and confusion were coded as dichotomous variables, which is somewhat oversimplified. Capturing the intensity of these perceptions would yield more accurate results. Second, informativeness was difficult to code due to its multi-dimensional nature and was a source of most disagreement among the coders. More precise measures should be used in future work. Further studies could also explore how stock photos compare against more authentic social media profile pictures.

In conclusion, we postulate that there is a tradeoff between informativeness and perceptual bias when increasing the number of information elements in persona profiles. Determining the optimum calls for awareness of how the information is perceived by the end users. Consequently, 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 live users can help in approaching the development of the optimal persona profiles. Moreover, results point to that, when developing personas, the end users in the organization need to be taken into account prior to deciding on the information content of the persona profile.

REFERENCES

1. J. Abdelnour-Nocera, T. Clemmensen, and M. Kurosu, "Reframing HCI Through Local and Indigenous Perspectives," *International Journal of Human-Computer Interaction* vol. 29, pp. 201-204, 2013.
2. T. Adlin and J. Pruitt, *The Essential Persona Lifecycle: Your Guide to Building and Using Personas*: Morgan Kaufmann Publishers Inc., 2010.
3. J. An, H. Kwak, and B. J. Jansen, "Personas for Content Creators via Decomposed Aggregate Audience Statistics," in *The 2017 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining (ASONAM 2017)*, Sydney, Australia 2017.

4. F. Anvari and H. M. T. Tran, "Persona ontology for user centred design professionals," in *The ICIME 4th International Conference on Information Management and Evaluation*, Ho Chi Minh City, Vietnam, 2013, pp. 35-44.
5. H. Beyer and K. Holtzblatt, *Contextual Design: Defining Customer-centered Systems*: Morgan Kaufmann Publishers Inc., 1998.
6. T. Blascheck, M. John, S. Koch, L. Bruder, and T. Ertl, "Triangulating User Behavior Using Eye Movement, Interaction, and Think Aloud Data," in *The Ninth Biennial ACM Symposium on Eye Tracking Research & Applications*, 2016, pp. 175–182.
7. J. Brickey, S. Walczak, and T. Burgess, "A Comparative Analysis of Persona Clustering Methods," in *Americas Conference on Information Systems (AMCIS2010)*, 2010, p. Article 217
<http://aisel.aisnet.org/amcis2010/217>.
8. L. Bridges, *Face Reading in Chinese Medicine*, 2nd ed. Ebook: Elsevier, 2012.
9. D. G. Cabrero, H. Winschiers-Theophilus, and J. Abdelnour-Nocera, "A Critique of Personas as representations of the other in Cross-Cultural Technology Design," in *The First African Conference on Human Computer Interaction*, 2016, pp. 149-154.
10. A. Cooper, *The Inmates Are Running the Asylum: Why High Tech Products Drive Us Crazy and How to Restore the Sanity (2nd Edition)*: Pearson Higher Education, 2004.
11. N. De Voil. (2010, 14 Aug). *Personas considered harmful*. Available:
<http://www.devoil.com/papers/PersonasConsideredHarmful.pdf>.
12. P. Dharwada, J. S. Greenstein, A. K. Gramopadhye, and S. J. Davis, "A Case Study on Use of Personas in Design and Development of an Audit Management System," in *Human Factors and Ergonomics Society Annual Meeting Proceedings*, Baltimore, Maryland, 2007, pp. 469-473.
13. V. L. Drego and M. Dorsey, "The ROI Of Personas," Forrester Research 3 Aug. 2010.
14. A. T. Duchowski, *Eye Tracking Methodology: Theory and Practice*. London: Springer, 2009.
15. N. Eger, L. J. Ball, R. Stevens, and J. Dodd, "Cueing Retrospective Verbal Reports in Usability Testing Through Eye-movement Replay.," in *Proceedings of the 21st British HCI Group Annual Conference on People and Computers: HCI, But Not As We Know It*, Swinton, UK, 2007, pp. 129–137.
16. C. Eridon. (2012, 14 Aug). *9 Questions You Need to Ask When Developing Buyer Personas*. Available:
<http://blog.hubspot.com/blog/tabid/6307/bid/30907/9-Questions-You-Need-to-Ask-When-Developing-Buyer-Personas.aspx>
17. E. Eriksson, H. Artman, and A. Swartling, "The Secret Life of a Persona: When the Personal Becomes Private," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, Paris, France, 2013, pp. 2677-2686.
18. I. R. Floyd, C. M. Jones, and M. B. Twidale, "Resolving Incommensurable Debates: A Preliminary Identification of Persona Kinds, Attributes, and Characteristics," *Artifact* vol. 2, pp. 12–26, 2008.
19. R. Frankel, S. , P. Kothari, and J. Weber, "Determinants of the informativeness of analyst research," *Journal of Accounting and Economics*, vol. 41, pp. 29-54, 2006.
20. E. Friess, "Personas and Decision Making in the Design Process: An Ethnographic Case Study," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, Austin, Texas, USA, 2012, pp. 1209-1218.
21. J. H. Goldberg, M. J. Stimson, M. Lewenstein, N. Scott, and A. M. Wichansky, "Eye Tracking in Web Search Tasks: Design Implications," in *The 2002 Symposium on Eye Tracking Research & Applications*, New York, NY, 2002, pp. 51–58.
22. E. Goodman, M. Kuniavsky, and A. Moed, *Observing the User Experience: A Practitioner's Guide to User Research*: Morgan Kaufmann, 2013.
23. K. Goodwin and A. Cooper, *Designing for the Digital Age: How to Create Human-Centered Products and Services*. Indianapolis, IN: Wiley, 2009.
24. J. Gothelf, "Using proto-personas for executive alignment," *UX Magazine*, p. Article No: 821, 2012.
25. J. Grudin and J. Pruitt, "Personas, participatory design and product development: An infrastructure for engagement," in *Participatory Design Conference*, 2002, pp. 144-152.
26. E. G. Guba and Y. S. Lincoln, *Competing Paradigms in Qualitative Research*: Sage, 1998.
27. R. Guðjónsdóttir and S. Lindquist, "Personas and Scenarios: Design Tool or a Communication Device," in *8th International Conference on Cooperative Systems (COOP'08)*, Carry-le-Rouet, France, 2008, pp. 165-176.
28. J. Gwizdka and M. Cole, "Does interactive search results overview help?: an eye tracking study," in *CHI'13 Extended Abstracts on Human Factors in Computing Systems*, 2013, pp. 1869–1874).
29. HHS. (n.d., 14 Aug). *Personas*. Available:
<https://www.usability.gov/how-to-and-tools/methods/personas.html>
30. C. G. Hill, M. Haag, A. Oleson, C. Mendez, N. Marsden, A. Sarma, and M. Burnett, "Gender-Inclusiveness Personas vs. Stereotyping: Can We Have it Both Ways?," in *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, Denver, Colorado, USA, 2017, pp. 6658-6671.
31. T. B. N. Hoang and J. Mothe, "Location extraction from tweets," *Information Processing & Management*, vol. 54, pp. 129-144, 2018.
32. A. Hutchison and L. Gerstein, "Emotion Recognition, Emotion Expression, and Cultural Display Rules:

- Implications for Counseling," *Journal of Asia Pacific Counseling*, vol. 7, pp. 19-35, 2017.
33. T. Intharah, D. Turmukhambetov, and G. J. Brostow, "Help, It Looks Confusing: GUI Task Automation Through Demonstration and Follow-up Questions," in *Proceedings of the 22nd International Conference on Intelligent User Interfaces*, Limassol, Cyprus, 2017, pp. 233-243.
 34. I. Jensen, H. Hautopp, L. Nielsen, and S. Madsen, "Developing international personas : A new intercultural communication practice in globalized societies," *Journal of Intercultural Communication*, vol. 43, p. Article 01, 2017.
 35. M. Jones and G. Marsden, *Mobile Interaction Design*: Wiley, 2006.
 36. T. Judge, T. Matthews, and S. Whittaker, "Comparing Collaboration and Individual Personas for the Design and Evaluation of Collaboration Software," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, Austin, Texas, USA, 2012, pp. 1997-2000.
 37. S. Jung, J. An, H. Kwak, M. Ahmad, L. Nielsen, and B. J. Jansen, "Persona Generation from Aggregated Social Media Data," in *ACM Conference on Human Factors in Computing Systems 2017 (CHI2017)*, Denver, CO, 2017, pp. 1748-1755.
 38. P. T. A. Junior and L. V. L. Filgueiras, "User modeling with personas," in *Proceedings of the 2005 Latin American conference on Human-Computer Interaction*, Cuernavaca, Mexico, 2005, pp. 277-282.
 39. H. Kwak, J. An, and B. J. Jansen, "Automatic Generation of Personas Using YouTube Social Media Data," in *Hawaii International Conference on System Sciences (HICSS-50)*, Waikoloa, Hawaii, 2017, pp. 833-842.
 40. Lieve Laporte, Karin Slegers, and D. D. Grooff, "Using correspondence analysis to monitor the persona segmentation process," in *The 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design (NordiCHI '12)*, 2012, pp. 265-274.
 41. F. Long, "Real or Imaginary; The Effectiveness of Using Personas in Product Design," in *The Irish Ergonomics Society Annual Conference*, Dublin, 2009, pp. 1–10.
 42. K. Machover, *Personality Projection in the. Drawing of the Human Figure: A Method of Personality Investigation*. Springfield, IL: Charles C. Thomas,, 1949.
 43. P. P. Maglio and C. S. Campbell, "Tradeoffs in displaying peripheral information," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, The Hague, The Netherlands, 2000, pp. 241-248.
 44. N. Marsden and M. Haag, "Stereotypes and Politics: Reflections on Personas," in *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, Santa Clara, California, USA, 2016, pp. 4017-4031.
 45. A. L. Massanari, "Designing for Imaginary Friends: Information Architecture, Personas, and the Politics of User-Centered Design," *New Media & Society*, vol. 12, pp. 401-416, 2010.
 46. J. McGinn and N. Kotamraju, "Data-driven Persona Development," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, Florence, Italy, 2008, pp. 1521-1524.
 47. M. L. McHugh, "Interrater reliability: the kappa statistic," *Biochemia Medica*, vol. 22, pp. 276–282, 2012.
 48. T. Miaskiewicz, S. J. Grant, and K. A. Kozar, "A Preliminary Examination of Using Personas to Enhance User-Centered Design," in *AMCIS 2009 Proceedings*, 2009, p. Article 697
<http://aisel.aisnet.org/amcis2009/697>.
 49. T. Miaskiewicz, T. Sumner, and K. A. Kozar, "A latent semantic analysis methodology for the identification and creation of personas," in *SIGCHI Conference on Human Factors in Computing Systems*, Florence, Italy, 2008, pp. 1501–1510.
 50. V.-W. Mitchell, G. Walsh, and M. Yamin, "Towards a Conceptual Model of Consumer Confusion," in *NA - Advances in Consumer Research*. vol. 32, G. Menon, A. R. Rao, and M. N. Duluth, Eds., ed: Association for Consumer Research, 2005, pp. 143-150.
 51. S. Mulder and Z. Yaar, *The User is Always Right: A Practical Guide to Creating and Using Personas for the Web*. Berkely, CA: New Rider, 2006.
 52. S. Negru and S. Buraga, "A Knowledge-Based Approach to the User-Centered Design Process," in *Knowledge Discovery, Knowledge Engineering and Knowledge Management. IC3K 2012. Communications in Computer and Information Science*. vol. 415, A. Fred, J. L. G. Dietz, K. Liu, and J. Filipe, Eds., ed Berlin, Heidelberg: Springer, 2013.
 53. L. Nielsen, "Persona for Berlingske Media, 2010," IT University of Copenhagen, Copenhagen, Denmark 2010.
 54. L. Nielsen, *Personas - User Focused Design*. London: Springer-Verlag, 2013.
 55. L. Nielsen and K. S. Hansen, "Personas is Applicable: A Study on the Use of Personas in Denmark," in *Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems*, Toronto, Ontario, Canada, 2014, pp. 1665-1674.
 56. L. Nielsen, K. S. Hansen, J. Stage, and J. Billestrup, "A Template for Design Personas: Analysis of 47 Persona Descriptions from Danish Industries and Organizations," *Int. J. Sociotechnology Knowl. Dev.*, vol. 7, pp. 45-61, 2015.
 57. J. E. Nieters, S. Ivaturi, and I. Ahmed, "Making personas memorable," in *CHI '07 Extended Abstracts on Human Factors in Computing Systems*, San Jose, CA, USA, 2007, pp. 1817-1824.

58. D. Norman. (2004, 1 Sep). *Ad-Hoc Personas & Empathetic Focus*. Available: http://www.jnd.org/dn.mss/personas_empath.html
59. A. D. Ouzts, N. E. Snell, P. Maini, and A. T. Duchowski, "Determining optimal caption placement using eye tracking," in *Proceedings of the 31st ACM International Conference on Design of Communication*, Greenville, North Carolina, USA, 2013, pp. 189-190.
60. R. Pichler. (2012, 14 Aug). *A template for writing great personas*. Available: <http://www.romanpichler.com/blog/persona-template-for-agile-product-management/>
61. J. Pruitt and T. Adlin, *The Persona Lifecycle: Keeping People in Mind Throughout Product Design*: Morgan Kaufmann Publishers Inc., 2005.
62. J. Pruitt and T. Adlin, *The Persona Lifecycle: Keeping People in Mind Throughout Product Design*: Morgan Kaufmann, 2006.
63. J. Pruitt and J. Grudin, "Personas: Practice and Theory," in *Proceedings of the 2003 Conference on Designing for User Experiences*, San Francisco, California, 2003, pp. 1-15.
64. C. Putnam, B. Kolko, and S. Wood, "Communicating about Users in ICTD: leveraging HCI personas," in *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development*, Atlanta, Georgia, USA, 2012, pp. 338-349.
65. K. Rönkkö, "An Empirical Study Demonstrating How Different Design Constraints, Project Organization and Contexts Limited the Utility of Personas," in *Proceedings of the 38th Annual Hawaii International Conference on System Sciences*, 2005, pp. 1530-1605.
66. C. Seidelin, A. Jonsson, M. Høgild, J. Rømer, and P. Diekmann, "Implementing Personas for International Markets: A Question of UX Maturity," in *Proceedings at SIDER'14 Stockholm*, Sweden, 2014.
67. J. Shaughnessy, E. Zechmeister, and J. Zechmeister, *Research Methods in Psychology*, 10th ed. Dubuque: McGraw-Hill Education, 2014.
68. R. Sinha, "Persona development for information-rich domains," in *CHI '03 Extended Abstracts on Human Factors in Computing Systems*, Ft. Lauderdale, Florida, USA, 2003, pp. 830-831.
69. M. Snyder, A. Sampanes, B.-K. White, and L. Rampoldi-Hnilo, "Personas on the Move: Making Personas for Today's Mobile Workforce," in *Design, User Experience, and Usability. Theory, Methods, Tools and Practice: First International Conference, DUXU 2011, Held as Part of HCI International 2011, Orlando, FL, USA, July 9-14, 2011, Proceedings, Part II*, A. Marcus, Ed., ed Berlin, Heidelberg: Springer Berlin Heidelberg, 2011, pp. 313-320.
70. C. Sturm, A. Oh, S. Linxen, J. A. Nocera, S. Dray, and K. Reinecke, "How WEIRD is HCI?: Extending HCI Principles to other Countries and Cultures," presented at the Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems, Seoul, Republic of Korea, 2015.
71. T. Tenbrink, "Cognitive Discourse Analysis: accessing cognitive representations and processes through language data," *Language and Cognition*, vol. 7, pp. 98-137, 2014.
72. E. Tribe. (2016, 29 Aug). *The Eye Tribe*. Available: https://en.wikipedia.org/wiki/The_Eye_Tribe
73. F. Zarrinkalam, M. Kahani, and E. Bagheri, "Mining user interests over active topics on social networks," *Information Processing & Management*, vol. 54, pp. 339-357, 2018.