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Persona Perception Scale: Development and Exploratory Validation of an Instrument for Evaluating Individuals' Perceptions of Personas

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ABSTRACT

Although used in many domains, the evaluation of personas is difficult due to the lack of validated measurement instruments. To tackle this challenge, we propose the Persona Perception Scale (PPS), a survey instrument for evaluating how individuals perceive personas. We develop the scale by reviewing relevant literature from social psychology, persona studies, and Human-Computer Interaction to find relevant constructs and items for measuring persona perceptions. Following initial pilot testing, we conduct an exploratory validation of the scale with 412 respondents and find that the constructs and items of the scale perform satisfactorily for deployment. The research has implications for both academic researchers and persona developers. Using the PPS, researchers and designers can evaluate how different persona designs affect individual perceptions of personas, for example persona users' (e.g., designers, marketers, software developers) perceived credibility of the persona and their willingness to use it. Because persona perceptions are associated with persona acceptance and adoption, using a perceptual measurement instrument can improve the chances of persona adoption and use in real organizations.

1. Introduction

Cooper (Cooper, 1999) introduced personas in software development as a user-oriented technique for analyzing and communicating the goals and needs of different user types. Thus, a persona is defined as a fictitious person representing a user type (Duda, 2018). Personas summarize core users or customers of an organization or a software system (Chang et al., 2008) and "help individuals realize how the users/customers are different from themselves" (Nielsen and Hansen, 2014) (p. 1667).

In addition to software development, personas have been widely used in other contexts, such as design (Dharwada et al., 2007), online marketing (Salminen et al., 2018), software security (Atzeni et al., 2011), and health informatics (LeRouge et al., 2013). Personas have been used for a variety of professional tasks, e.g., to analyze users of websites, mobile applications, gamers, users of public health services, and target groups of advertising campaigns (Dong et al., 2007, Nacke et al., 2010, Reeder and Turner, 2011, Salminen et al., 2018). For example, Cooper (Cooper, 1999) discusses the use of personas in determining the design of an inflight video system. Dharwada et. al. (Dharwada et al., 2007) demonstrate the use of personas in the development of an audit management system. Personas are also applied by corporate decision makers to craft customer-oriented strategies (Jenkinson, 1994). In these activities, the use of personas can increase the profitability and productivity of an organization (Forrester Research 2010). From surveys of commercial and other organizations, the use of personas is well-established and integrated into the design process of many products (Nielsen et al., 2015).

Personas are typically created using qualitative data collection techniques (e.g., interviews, ethnographies) and presented as a persona profile consisting of one or two pages of images and text about the fictitious person. Figure 1 illustrates a typical persona profile. To encourage users to relate to personas as a 'real' person, persona profiles typically provide information about the personas' motivations, frustrations, and motivations, along with demographics and domain-specific information, such as brand preferences (see Figure 1).

2. Related literature and concepts

2.1. Persona evaluation

There are many benefits of persona use, including heightened user

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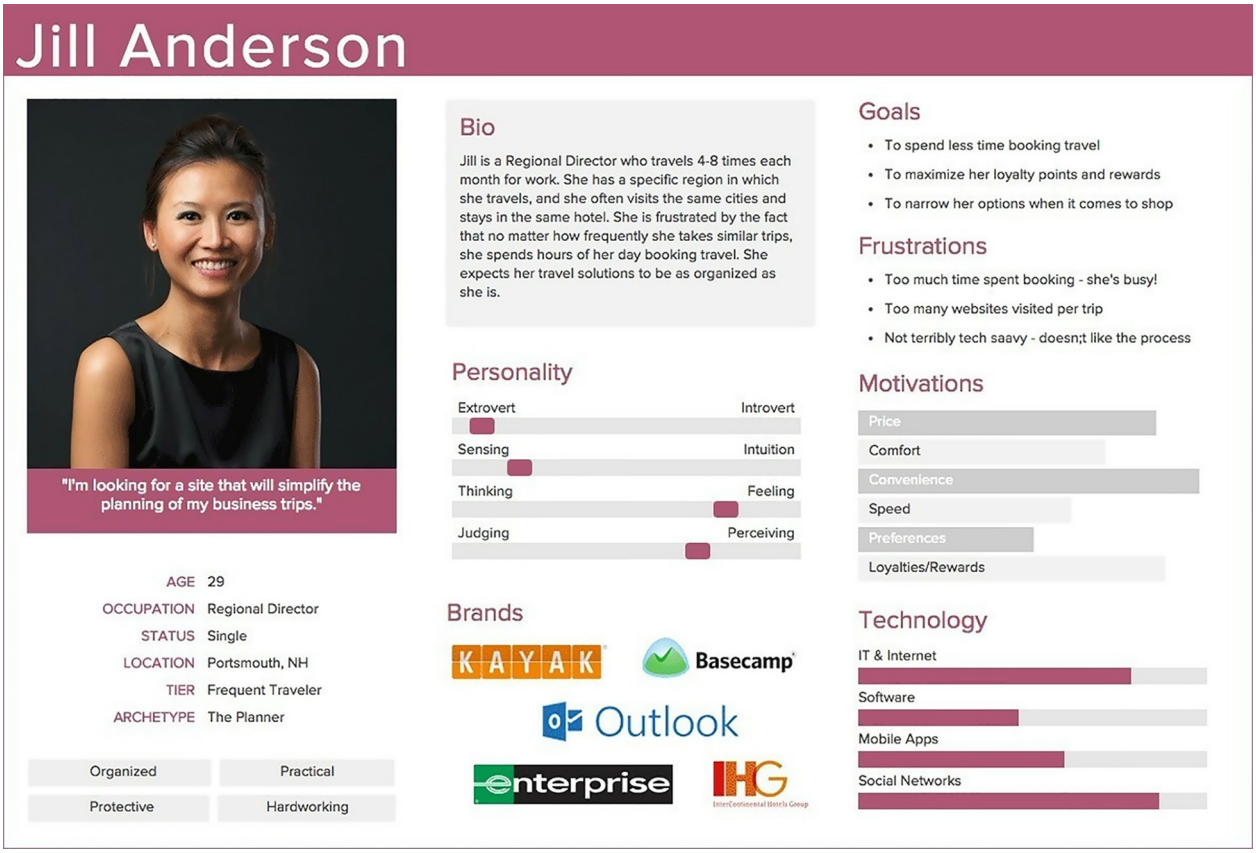

Figure 1. Example of a typical persona profile (keepitusable 1999), although the layout and content can somewhat vary.

immersion (Mori et al., 2019), communication about customers among decision-makers, and use of personas as mental models to constantly keep customers in mind (An et al., 2018, An et al., 2018, Nielsen, 2013, Nielsen and Hansen, 2014). Despite these benefits, researchers have reported various challenges in the adoption and usage of personas, particularly those created through qualitative methods. One of the most common concerns is that the true accuracy of personas is difficult to verify, as there are no metrics researchers commonly agree upon (Salminen et al., 2020). Accuracy in the persona context is defined such that a more accurate persona better corresponds to the underlying average traits of the user segment that is describing. Conversely, a less accurate persona deviates more from these traits.

Another major concern is that the created personas can be biased by a number of factors, including (a) persona creators' willingness to push for a private agenda (e.g., developing personas that they *think* should be the core users, rather than accurately describing those that are (Rönkkö, 2005, Vincent and Blandford, 2014)), (b) the creators' implicit prejudices or personal biases (Hill et al., 2017, Massanari, 2010), and/or (c) unreliable responses given by the interviewed users—for example, the social desirability bias (Fisher, 1993).

Following these concerns, evaluation of personas is a major issue facing researchers and creators in the field. Researchers in the persona domain have repeatedly discovered that personas need justification from their end users, mainly for their accuracy and usefulness in real organizations and for actual usage scenarios (Chapman and Milham, 2006, Friess, 2012, Matthews et al., 2012). However, there are not validated survey instruments that measure how personas are perceived by end users (e.g., designers, marketers, software developers, etc.). In contrast, previous studies typically evaluate personas via case studies (Dharwada et al., 2007, Faily and Flechais, 2011, Jansen et al., 2017), ethnography (Friess, 2012), usability standards (Long, 2009), or statistical goodness-of-fit evaluation (An et al., 2017, An et al., 2018, Zhang et al., 2016). For example, Friess (Friess, 2012) investigated the adoption of personas among designers by counting how often personas were referred to in discussions. Long (Long, 2009) measured the effectiveness of using personas by employing usability heuristics. Nielsen et al. (Nielsen et al., 2017) analyzed the match between journalists' beliefs about their audience characteristics and the personas aggregated from the user statistics of the same organization. Using topic modelling and quantitative persona generation, An et al. (An et al., 2017) predicted how personas are likely to differ by their preferences of new online content.

Table 1 displays some of the techniques applied to evaluate personas in previous literature. Note that the list is not exhaustive – nonetheless, we can conclude that qualitative case studies and use of statistical metrics (e.g., distance of clusters (Brickey et al., 2010)) constitute the most typical methods of persona evaluation.

While the existing persona evaluation techniques are interesting and useful, it is also possible to approach the problem of persona evaluation from another angle, specifically that of survey-based measurement, as commonly applied in social sciences including psychology, marketing (Ilieva et al., 2002, Sudman et al., 1996) and user engagement (O'Brien and Toms, 2010). In previous literature, apart from the pilot study of Salminen et al. (Salminen et al., 2018), there has been no systematic effort to develop a measurement scale for individuals' persona perception.

In Human-Computer Interaction (HCI), perceptual measurement has been deployed, e.g., in the context of virtual agents (Hasler et al., 2013), robots (Tay et al., 2014), and chatbots (Banks, 2019). Overall, users' perceptions toward a system have been shown to impact their willingness to adopt that system (Darban and Polites, 2016). To examine such perceptions, survey-based data collection and associated techniques for latent factor analysis, such as structural equation modeling, are highly appropriate (Barrett, 2007). Consequently, we propose

Table 1
Examples of persona evaluation techniques.

Technique	Explanation	Reference
Case studies	Conducting qualitative case studies (interviews, ethnography) within organizations to record the use, usefulness, and impact of personas on end users' decision making.	(Friess, 2012, Jansen et al., 2017, Rönkkö, 2005, Rönkkö et al., 2004)
Quantitative analysis	Employing technical metrics, such as distance, goodness-of-fit, or accuracy to determine the statistical validity of a persona.	(An et al., 2017, An et al., 2018, Salminen et al., 2019, Brickey et al., 2010)
Usability	Using usability standards or heuristics to evaluate persona designs.	(Long, 2009)
Information content	Investigation of information shown in persona profiles and how it serves decision makers' needs.	(Nielsen et al., 2015)
Prediction	Analyzing how well predictions made with personas hold.	(An et al., 2018)
Stability analysis	Analyzing how stable personas remain over time. Rapidly changing personas would potentially indicate methodological problems.	(An et al., 2017)
Survey	Measuring end users' perception of personas as latent constructs	(Salminen et al., 2018)

that survey-based methods provide a feasible alternative for understanding how end users perceive personas.

This approach seems intuitively compatible with personas, as researchers have reported several key perceptions relating to the creation, adoption, and use of personas, including, credibility (Rönkkö, 2005), accuracy (Chapman and Milham, 2006), trust (Blomquist and Arvola, 2002), immersion (Matthews et al., 2012), and perceived usefulness (Chapman et al., 2008). Also, prior research has established that persona perceptions vary individually (Hill et al., 2017, Marsden and Haag, 2016, Salminen et al., 2018). It is, therefore, appropriate to approach persona evaluation with a survey-based approach, as survey research constitutes one of the established methodologies of accounting for preference variation among individuals.

In particular, our research purpose is to *develop a measurement scale that captures the most relevant persona-related perceptions of persona users*. We achieve this by reviewing the literature and selecting relevant constructs and formulating items to measure them. We identify commonly occurring perceptions associated with personas. After identifying the key perceptions from persona literature, we retrieve analogous constructs from social psychology to formulate robust measurement items for the chosen constructs.

This research builds on the exploratory work by Salminen et al. (Salminen et al., 2018) that presented preliminary results on the Persona Perception Scale (PPS) through a pilot study with 19 respondents. In this research, we expand that earlier study by using a sample of 412 respondents, giving clearer insights in a more rigorous empirical setting as well as adhering to repeated testing, as recommended for scale development (DeVellis, 2016). Overall, our aim with the PPS scale development is to create a survey instrument that is (a) grounded in prior research, (b) tested for construct and content validity, and (c) can be easily deployed by persona researchers and creators.

In the following section, we provide a definition for the concept of persona perception. After this, we explain our methodology for literature collection and analysis and provide a detailed rationale for the selection of each construct. After this, we summarize the results of the pilot study with 19 participants. We then conduct repeated testing by administering the survey to 412 respondents to conduct an initial validation of the scale. We conclude by reporting our findings, discussing their implications for persona research and practice, and outlining practical examples on how practitioners can deploy the developed PPS instrument.

Regarding terminology, the reader should note that "persona end user" and "persona user" refer to the group of people; namely, those using personas to make decisions in their work. In contrast, personas are created by inferring information from "users" of an organization (e.g., users of software system, customers using a product). Decision makers "use" personas by reviewing persona profiles in order to understand relevant aspects of the "users" that the persona typifies. The actual use of personas varies by the task at hand, as different professional tasks require the decision makers to pay attention to different aspects of the persona.

2.2. From person perception to persona perception

The concept of person perception from social psychology research guides our thinking about persona perception. Person perception can be defined as "a general tendency to form impressions of other people" (Psychology Research and Reference 2018); in other words, attaching particular beliefs to another person. The beliefs that individuals attribute to others can relate to looks, demographics, behaviors, dispositions, and so on (Ambady and Rosenthal, 1992). Person perception can also be seen as the process resulting a set of belief or attitudes about others (Swann, 1984) by attribution of characteristics (Jones and Davis, 1965).

The concept of person perception has previously been proposed in the context of personas by Marsden and Haag (Marsden and Haag, 2016) who particularly associate it with stereotyping and biases. We postulate, following Marsden and Haag (Marsden and Haag, 2016), that *persona* perception is a subjective experience, in which *personas* give faces to data and are perceived as real people, not as anonymous users or customer groups (Pruitt and Grudin, 2003).

Because personas are human-like representations of user information, they are likely to be judged as people by other people (Turner and Turner, 2011). According to Long (Long, 2009), end users of personas implicitly superimpose attributes to personas, and this process typically involves biases and stereotyping, as noted by Marsden and Haag (Marsden and Haag, 2016), Hill et al. (Hill et al., 2017), and Salminen et al. (Salminen et al., 2018). In other words, personas are associated with sense-making that arises, on the one hand, from the information selected by the persona developers and, on the other hand, from the end users' experiences (Nielsen et al., 2017). Preconceptions, stereotypes, and affective predispositions commonly affect persona interpretation (Marsden and Haag, 2016). Individuals show emotional connections to humanlike interfaces (Araujo, 2018), which is a key reason why humanization of systems – or, in the case of personas, user data – takes place (An et al., 2018).

Following this logic, we define *persona* perception as *a set of key beliefs that individuals intuitively associate with personas.* In other words, *common aspects of the personas that are judged or paid attention to when processing persona profile information.* The persona perception is, therefore, mediated by individual experience – thus, there is no "right way" to perceive personas, but the perception is phenomenologically unique and determined by the individual end user of the persona.

Two important notions arise from this premise. First, it is in line with the extant persona research postulating that personas are experienced subjectively. For example, Rönkkö et al. (Rönkkö et al., 2004) found that two teams had conflicting views of the persona despite being shown the same persona information. Second, the above premise denotes a departure from the assumption that personas should be *solely* evaluated by measuring how correct or accurate (in a technical sense) they are. To position our premise correctly, we highlight the importance of *many* types of validation. Personas should be verified for accuracy – meaning that they represent the users realistically and

Table 2
Considered and chosen constructs. ✓ indicates chosen, × indicates not chosen.

Construct	Reference	Chosen	Repeatedly cited in persona literature	Repeatedly cited in person perception literature	Conceptual overlap with another construct	Other
Believability	(Cooper, 1999, Howard, 2015, Miaskiewicz et al., 2008, Pruitt and Grudin, 2003)	×	x		x (credibility)	
Clarity	(Dantin, 2005, Hudson, 2013, Madsen et al., 2014, Nielsen and Hansen, 2014)	✓	x			
Completeness	(Bødker et al., 2012, Chapman and Milham, 2006, Nielsen, 2004)	✓	x			
Consistency	(Bødker et al., 2012, Chapman and Milham, 2006, Matthews et al., 2012)	✓	x			
Credibility	(Chapman and Milham, 2006, Howard, 2015, Matthews et al., 2012, Salminen et al., 2019, Vincent and Blandford, 2014)	✓	x			
Empathy	(Friess, 2012, Pruitt and Grudin, 2003, Salminen et al., 2018)	✓	x	x		
Familiarity	(Moreland and Zajonc, 1982, Stevens et al., 2016)	×		x	x (similarity)	
Identification	(Booth, 2008, Hogg and Abrams, 1988)	×		x	x (empathy)	
Immersion	(Chang et al., 2008, Marsden and Haag, 2016, Miaskiewicz et al., 2008, Nielsen, 2013)	×	x		x (empathy)	
Interestingness	(Chu et al., 2013, Knight and Pandir, 2004)	×			x (likability)	
Interpersonal attraction	(Byrne, 1961, McCroskey and McCain, 1974)	×		x	x (likability)	
Likability	(Nesler et al., 1993, Reysen, 2005)	✓		x		
Relatability	(Lindley and Potts, 2014, Vines et al., 2015)	×			x (empathy)	
Similarity	(Cantor and Mischel, 1979, Liviatan et al., 2008, Moreland and Zajonc, 1982)	✓		x		
Stereotypes	(Hill et al., 2017, Marsden and Haag, 2016, Salminen et al., 2018, Turner and Turner, 2011)	×	x			x*
Trustworthiness	(Cooper, 1999, Howard, 2015, Miaskiewicz et al., 2008, Pruitt and Grudin, 2003)	×	x		x (credibility)	
Usefulness	(Kim et al., 2011, Swearingen and Sinha, 2001)	×	x		x (WTU)	
WTU**	(Howard, 2015, Nielsen and Hansen, 2014, Rönkkö, 2005, Rönkkö et al., 2004)	✓	x			

* Not clearly operationalizable as a latent construct
** Willingness to use

truthfully, being faithful to the underlying data. In addition, they should be evaluated perceptually, to investigate how different individuals respond to different personas. The importance of perceptions is evident from the user study of Salminen et al. (Salminen et al., 2018), where the persona's race and gender attributes affected persona users' perceptions of credibility, judgment, and confusion.

Note that the concepts of *person* and *persona* perceptions are somewhat different from their perceptual expectations. For example, personas have a degree of artificiality as fictitious representations, so being credible is perhaps more relevant for persona perception than person perception. Such conceptual differences drive our construct selection process. Moreover, to avoid redundancy, we exclude closely matching constructs. For example, as likability and interpersonal attractiveness are similar phenomena, we only included one of them. This is intended to improve the discriminant validity of the scale (Abdi, 2003). The persona perceptions and the associated literature are explained in the following section.

3. Subscale Development

The research design follows the scale development approach of DeVellis (DeVellis, 2016), which is similar to other approaches (see Hinkin (Hinkin, 1995) for a review) . In summary, we (1) define the studied concept, (2) collect relevant literature, (3) develop an initial pool of constructs and items, (4) refine the constructs and items based on expert feedback, (5) develop the survey, (6) perform pilot testing to detect potential issues with the items, and (7) validate the survey instrument with a larger sample for consistency and reliability.

3.1. Literature collection and analysis

3.1.1. Search strategy

The literature review, conducted in September 2019, involved determining what user perceptions are important in the persona context, and adopting relevant items (when available) to measure these perceptions from previous literature in related fields. If relevant items were not found, they were created anew to reflect the particular construct in the persona context, using previous persona research as a source of inspiration.

To find relevant literature, we searched the ACM Digital Library using relevant search phrases (e.g., personas + perceptions; personas + credibility, personas + impressions, etc.), as well as using snowball sampling to identify more sources from the read articles dealing with user perceptions of personas. We focused on persona studies that were published in peer-reviewed conferences such as the 'ACM Conference on Human Factors in Computing Systems' (CHI), 'ACM User Modelling, Adaptation and Personalization' (UMAP), and so on; as well as peer-reviewed journals such as 'Computers in Human Behavior', 'International Journal of Human Computer Studies', 'Human-Computer Interaction', and 'International Journal of Human-Computer Interaction'.

In total, 78 persona research articles were collected and read at the first step of the literature review. The purpose of this part of the literature analysis was to understand what perceptions (i.e., constructs) are conceptually important for persona perception. To accomplish this, two of the researchers read the collected articles and recorded relevant perceptions in a spreadsheet. This list of perceptions was later supplemented by other perceptions discovered in the second step of the literature review, to identify other potentially relevant constructs.

After establishing the initial list of persona perceptions, we expanded the literature base to social psychology and HCI research by searching Google Scholar and Science Direct for articles that (a) deploy survey-based measurement AND (b) deal with one or more of the identified constructs. These searches yielded 73 research articles. Thus, in total, 151 research articles (78 + 73) were read to (a) better understand what perceptions matter in the persona context and (b) how these perceptions could be captured using items from the wider HCI and social psychology literature.

3.1.2. Selection of constructs and items

We used this literature base to (a) expand the list with other, potentially relevant constructs, and to (b) find measurement items (indicators) for the constructs that were eventually chosen for the PPS scale. This was done by reading the articles and recording constructs and measurement items in a spreadsheet.

We chose the PPS constructs following the guidelines of scale development by DeVellis (DeVellis, 2016). First, one of the authors performed the literature review and collected a preliminary list of possible constructs. Second, this list of candidate constructs (see Table 2) was analyzed in detail by another researcher to evaluate the relevance of the constructs for the persona context. Possible disagreements were discussed, and the list was pruned accordingly. This approach, akin to iterative collaborative coding (Cornish et al., 2013), was applied to achieve a dialogue between the researchers and agreement over the relevance of the constructs for the research problem at hand. From the literature, 18 constructs were identified, of which eight constructs were selected for the PPS, and ten constructs rejected.

A similar approach was taken to identify items for the chosen constructs. This was done in a collaborative manner by two of the researchers; the first one retrieving items and the second one agreeing/disagreeing to their inclusion. Through this collaborative process, the researchers jointly agreed on the use of the chosen items, which were then shared with the domain experts (as explained in the following subsection).

3.1.3. Expert feedback

To enhance content validity (Gehlbach and Brinkworth, 2011) of the PPS, we asked four persona experts for their feedback on the scale. These persona experts–two currently working in academia, both with several research publications over a lengthy period of time; two from reputable companies using personas and with academic publishing background of personas– were identified through previous research collaboration and based on their persona-related publication activity. The experts were provided the exact constructs and items, along with the definitions of the constructs, and asked to evaluate if they made sense in the persona context. The experts were not vetted for prior experience in scale development, as we wanted their opinion specifically on content validity (i.e., that the constructs and items make sense in the persona context), rather than other aspects of validity that we test using other methods explained in Sections 3.3 and 4). We provided the experts with the questionnaire items and descriptions of the constructs and asked for their comments on their relevance, appropriateness in the persona context, as well as feedback on the wording of the items. Based on the expert comments, we adjusted the wording on some of the items (e.g., we tied the items of the *Willingness to use* (WTU) construct more closely to the particular work task scenario) as well as removed some items (e.g., an initial item for empathy, "I find that I am 'in tune' with this persona", was removed as confusing). While the expert suggestions resulted in changes at the item-level, the constructs remained as the ones determined from the literature review. The following subsection provides justification for the PPS constructs and items.

3.1.4. PPS constructs and items

3.1.4.1. Credibility. Credibility is a key issue in persona perception, because if decision-makers do not trust the personas, the personas is not adopted or used in real decision-making situations (Vincent and Blandford, 2014). For example, in a study by Matthews et al. (Matthews et al., 2012), roughly a third of the participants were negative (5 out of 14), finding the created personas abstract, impersonal, misleading, and distracting. While close to half (6 out of 14) of the participants were neutral to moderately positive about the personas (Matthews et al., 2012), the study highlights personas'

credibility challenges.

As personas have traditionally been created using subjective methods, such as interviews and ethnographic work, the small sample sizes and potential creators' biases associated with these methods have raised concerns about the accuracy and reliability of personas (An et al., 2016, Chapman and Milham, 2006, Howard, 2015). The sharpest critique argues personas are beyond the scope of scientific validation altogether (Chapman and Milham, 2006) because personas are, by definition, imaginary people (Long, 2009).

While the lack of credibility tends to arise from persona creation using relatively few qualitative interviews without formal representativeness of the actual user base, even when the personas are created from quantitative data, issues of trust can emerge. For example, in a user study that tested data-driven persona profiles (Salminen et al., 2018) based on large volumes of quantitative data, it was found that some participants questioned the legitimacy of personas. This perception can occur, for example, because the personal experiences of decision makers conflict with personas (Chapman and Milham, 2006) so decision-makers hold on to their existing beliefs instead of those suggested by "abstract" personas. In the PPS, we capture these dynamics in the *Credibility* construct (see Table 3).

Item 1 for credibility ("The persona seems like a real person.") is inspired by the realism and authenticity constructs applied in various HCI studies. For example, Poeschl and Doering (Poeschl and Doering, 2013) developed a VR realism scale and Neururer et al. (Neururer et al., 2018) studied perceptions of authenticity in chatbots. These studies have deployed similar items (see e.g. [109:36]) to measure realism in their contexts. In the persona literature, researchers consistently maintain that personas should appear as 'real people' to their users (An et al., 2018, Cooper, 1999, Long, 2009, Massanari, 2010). Item 2 ("I have met people like this persona.") is inspired by Turner and Turner (Turner and Turner, 2011) who discuss the inevitability of stereotyping in user perceptions of personas. This stereotypical thinking arises partly from encounters with real individuals the user perceives to be like the persona – thus, persona credibility is enhanced by the ability of its user to relate the persona to individuals they have previously met.

Item 3 ("The picture of the persona looks authentic.") is inspired, firstly, by the findings that pictures are important for persona user perceptions in general (Hill et al., 2017, Jensen et al., 2017) and, secondly, that the authenticity of the picture plays a central role in these perceptions (Salminen et al., 2019). Item 4 ("The persona seems to have a personality.") is inspired by Baylor and Ryu (Baylor and Ryu, 2003) who developed an instrument to assess pedagogical agent personas – the logic is that the persona is 'not only a face', but appears to be a real person with personality (original item: "Agent has a personality." [(Baylor and Ryu, 2003):299]).

It is important to distinguish actual accuracy and perceived credibility. The latter is a *perception* of how well the persona matches reality (i.e., how believable the persona appears (Edwards et al., 2016)) and can vary from the actual accuracy of the developed persona (i.e., one that corresponds to real user data), for example, if the end user has misconceptions of the actual user behavior. In such a case, credibility could be high for inaccurate personas if they are presented in a believable way or in a way that matches the persona user's preconceptions. Therefore, the actual accuracy of a persona is better measured objectively using hard metrics and quantitative analysis (Chapman et al., 2008), whereas the *perception* of credibility is a conceptually separate construct.

3.1.4.2. Consistency. Chapman and Milham (Chapman and Milham, 2006) highlight the consistency problem arising when the personas are pieced together from several unrelated data sources. Bødker et al. (Bødker et al., 2012) refer to such patched-up personas as "Frankenstein's monsters", as their creators manually piece together unrelated information about the users from multiple sources. Because persona creation lacks strict conventions and guidelines (Nielsen et al., 2015), there are many different ways to create personas. The lack of standardization and unity can therefore enhance the state of inconsistency, both in terms of persona creation (through different designs) and persona perceptions (through difficulties of users "learning" different persona designs).

In the PPS, these aspects are covered by the *Consistency* construct (see Table 4). Item 3 ("The persona information seems consistent.") addresses the general aspect of consistency. Inconsistencies, however, often arise between different information elements of the persona profile, which results in mismatched perceptions and confusion among the end users. The persona picture, particularly, is expected by the users to match the demographic information in the persona profile (Hill et al., 2017, Salminen et al., 2018), which is reflected in Item 2 ("The picture of the persona matches other information shown in the persona profile.").

In addition to manually created personas, lack of consistency can be also be a problem for automatically created personas that combine data from several online sources (An et al., 2016), especially when the data cannot be mapped with user IDs. For example, persona quotes and other information of data-driven personas can conflict – if the persona is interested in sports, but the shown quotes talk about fashion, the persona users find the presented information inconsistent. Similarly, demographics can conflict with other information; e.g., a persona's name might not match the country and age group of the persona. These discrepancies are discussed in (Salminen et al., 2019), observed in various persona user studies (Nielsen et al., 2017, Salminen et al., 2018, Salminen et al., 2019), and reflected in Items 1 ("The quotes of the persona match other information shown in the persona profile.") and 4 ("The persona's demographic information (age, gender, country) corresponds with other information shown in the persona profile.").

3.1.4.3. Completeness. Completeness refers to the persona having all the essential information for its application. Determining the information content shown in the persona profiles (i.e., persona information design) is a crucial step in the persona creation process (Pruitt and Adlin, 2006), as it has direct implications for the intended use of the persona.

However, persona information design is not a trivial task. Chapman and Milham (Chapman and Milham, 2006) observe the problem of representativeness, meaning the more attributes one adds, the more possible personas with different attribute combinations there are. This exponentially increases the required data to accurately describe all the personas. Thus, Chapman and Milham (Chapman and Milham, 2006) argue that persona information selection is often arbitrary, as persona developers do not even attempt to cover all possible personas. They also

Table 3
Credibility definition and items.

Definition	Item	Reference
Measures how credible (realistic, authentic) the persona appears.	The persona seems like a real person.	(Poeschl and Doering, 2013)
	I have met people like this persona.	(Turner and Turner, 2011)
	The picture of the persona looks authentic.	(Salminen et al., 2018)
	The persona seems to have a personality.	(Baylor and Ryu, 2003)

Table 4
Consistency definition and items.

Definition	Item	Reference
Measures how consistent the different information in the persona profile is.	The quotes of the persona match other information shown in the persona profile.	(Salminen et al., 2019)
	The picture of the persona matches other information shown in the persona profile.	(Salminen et al., 2018)
	The persona information seems consistent.	(Bødker et al., 2012)
	The persona's demographic information (age, gender, country) corresponds with other information shown in the persona profile.	(Salminen et al., 2019)

Table 5
Completeness definition and items.

Definition	Item	Reference
Measures how well the persona captures essential information about the users it describes.	The persona profile is detailed enough to make decisions about the customers it describes.	(Thoma and Williams, 2009)
	The persona profile seems complete.	(Turner and Turner, 2011)
	The persona profile provides enough information to understand the people it describes.	(Thoma and Williams, 2009)
	The persona profile is not missing vital information.	(Turner and Turner, 2011)

argue that it is not possible to distinguish between relevant and irrelevant attributes of a persona, as any information can matter for a use case. In the worst scenario, the chosen information takes away persona users' attention from the task at hand (Long, 2009, Matthews et al., 2012). Incomplete information is also associated with lack of usefulness and willingness to use personas. For example, Bødker et al. (Bødker et al., 2012) reported that the personas developed in their study were not perceived as actionable, resulting in resistance for adopting personas in professional use.

We aim to capture these aspects in the *Completeness* construct (see Table 5). In persona development, creating 'rounded' personas refers to exhaustive information content about the persona's characteristics, desires, needs, wants, and behaviors (Howard, 2015). As Turner and Turner note (Turner and Turner, 2011), "there is a need to create compelling, rounded personas" (p. 35). The aspect of roundedness is considered in Item 2 ("The persona profile seems complete.") and Item 4 ("The persona profile is not missing vital information.").

The end users' information needs vary by use case for which the persona is created. Thoma and Williams (Thoma and Williams, 2009) highlight the importance of fully-rounded personas for product development decision. According to Nielsen (Nielsen, 2004), it is important that personas represent the underlying user data as a rounded character, which allows decision-makers to focus on the users. This aspect of applicability is reflected in Item 1 ("The persona profile is detailed enough to make decisions about the customers it describes.") and Item 3 ("The persona profile provides enough information to understand the people it describes.").

3.1.4.4. Clarity. Persona studies consider clarity from two angles. First, clarity of the persona profile (text, pictures, etc.) can influence end-user perceptions. Second, the persona information can be ambiguous and unclear, so the end users are confused about what they are seeing. For example, Madsen et al. (Madsen et al., 2014) note that "Without clarity, it is impossible to communicate about the specific needs and goals of the users and […] meet these [needs]." (p. 1). By contrast, Salminen et al. (Salminen et al., 2018) found confusion when content creation professionals were exposed to personas. Some of the confusion arose from unclear definitions in the persona profiles – e.g., it was not clear if the "Quotes" section of the persona profile had comments *about* the persona or *by* the persona. For personas to be useful, they need to present the information of the target group they are describing in a clear manner. Nielsen et al. (Nielsen et al., 2015) reviewed 47 different ways to represent personas, stressing the importance of having generic guidelines for creating personas that can be intuitively understood.

We aim to capture these aspects in the *Clarity* construct (see Table 6). As clarity is particularly associated with the presentation of the persona profile (e.g., choice of text, images, colors, etc.), as well as the persona information itself, measuring clarity in the persona context requires particular focus on both the persona information (see Item 3 in Table 6: "The information in the persona profile is easy to understand.") and its presentation (Item 1: "The information about the persona is well presented." and Item 2: "The text in the persona profile is clear enough to read."). Memorability is associated with the experiential view of the persona and considered to reflect the facets of clarity in a sense that 'a clear persona is a memorable persona' (Item 4: "The persona is memorable."). Memorability (or recall) of personas is considered as a design goal (Nieters et al., 2007), meaning that ideally users would not immediately forget about the persona(s) they focused on.

3.1.4.5. Likability. Likability was chosen as a construct for two reasons. First, because it is a central concept in person perception literature. For example, Reysen (Reysen, 2005) has previously created a likability scale. Positive attitudes towards a person have been found impactful in psychological studies. For example, the "what is beautiful is good" effect (Dion et al., 1972) postulates that people perceived as more beautiful are also perceived as more successful. However, the concepts of beauty and attractiveness typically imply a cross-gender relationship (or sexuality) between the target and the perceiver (Tidwell et al., 2013). In turn, likability is a more universal concept, still capturing the conceptual dimension of positive affect (see Table 7). For this reason, we chose likability from the available positive affect dimensions.

Second, likability has been associated with several constructs relevant to personas, including empathy (Plank et al., 1996), consistency (Isbister and Nass, 2000), and social distance or similarity (Kim and Mutlu, 2014). For this reason, likability may be involved as a moderator in the relationships between the other PPS constructs. As we envision the PPS to test such relationships and related hypotheses, we chose to include likability in the instrument. Items 1 and 2 are adopted from the Reysen likability scale (original item for Item 1: "This person is likeable." and for Item 2: "This person is friendly.") (Reysen, 2005). Item 3 ("This persona feels like someone I could spend time with.") is inspired by Nelson et al. [(Nelson et al., 2014):3] who mention "spending more time" as an indicator for positive interaction. Item 4 ("This persona is interesting.") is adopted from Baylor and Ruy [(Baylor and Ryu, 2003):299] (original item: "Agent was interesting.").

3.1.4.6. Empathy. Empathy is another central concept for personas. It can be defined as a feeling of understanding and compassion (Singer and Klimecki, 2014). In the literature, personas provide a shared mental model of the end users' needs and wants, summarizing

Table 6
Clarity definition and items.

Definition	Item	Reference
Measures how clearly the persona information is presented.	The information about the persona is well presented.	(Mulken et al., 1998)
	The text in the persona profile is clear enough to read.	(Campanella et al., 2007)
	The information in the persona profile is easy to understand.	(Albers, 2008)
	The persona is memorable.	(Nieters et al., 2007)

information about users in an empathetic format that is more memorable than numbers and tables (Goodwin, 2009, Pruitt and Adlin, 2006). Since humans tend to be receptive to narratives (Polkinghorne, 1988), persona-centric storytelling facilitates absorption of the persona information (Madsen and Nielsen, 2010). Persona descriptions often aim at using this human tendency by communicating personas as narratives, e.g., "Mary is a 35-year-old woman who likes extreme sports and dreams of having a vacation in Hawaii just by herself." A persona can convey experiences that the decision makers would not necessarily know otherwise, facilitating immersion into the role and circumstances of the user (Howard, 2015). This can help curb the tendency to create self-referential designs (Long, 2009).

The psychological benefits of personas are rooted in an empathetic understanding of the persona (Miaskiewicz and Kozar, 2011) – through cognitive processing of persona information, end users immerse themselves in real situations of others, as well as predict the persona's behavior under different circumstances (Pruitt and Grudin, 2003). This mental modeling relies on human beings' innate ability of empathy and immersion (Krashen, 1984), and it is, therefore, a powerful agent for motivation and purpose. In theory, empathy improves recall of the personas, helps communicate about their needs, and encourages end users of personas to keep them constantly in mind (Nielsen and Hansen, 2014).

Table 8 defines empathy for our purpose and presents the measurement items. Item 1 is adopted from the *Rapport* construct by Kim and Mutlu [(Kim and Mutlu, 2014):789] (original item: "I understand the robot and which it really is."), replacing 'robot' with a persona, while maintaining the meaning of empathetic understanding of the entity. Item 2 is adopted from Cameron (Cameron, 2004), where ties are defined as "perceptions of similarity, bond, and belongingness with other group members" (p. 241), with the original item being "I feel strong ties to other (ingroup members)" (p. 244). Item 3 is inspired by the notion of perspective-taking (Galinsky et al., 2005), which means setting one's self into the position of others. This notion is close to what persona literature means by empathy and thus we created Item 3 based on the research by Galinsky et al. (Galinsky et al., 2005) that makes several references to how empathy can be proxied by imagining the life of the other person – e.g., "participants are instructed to imagine how the person in the tape feels, focusing on how the events have affected his or her life." (p. 114) and "participants writing a narrative essay about the typical day in the life of a person in a photograph." (p. 115). This idea is incorporated in Item 3 of Empathy ("I can imagine a day in the life of this persona.").

3.1.4.7. Similarity. Similarity refers to the experienced likeness between the persona and the end user. For example, Booth (Booth, 2008) found interesting effects of similarity when analyzing fan-created personas, labeling them as 'narrative identification' and implying that the creation of personas could strengthen the bond between fans and target personages.

Prior research has identified several types of similarity perceptions. These include, for example, value similarity (Vaske et al., 2007), race–gender similarity (Tidwell et al., 2013), and personality similarity (Oviatt et al., 2004). Moreover, familiarity, similarity, and attraction are determined as associated concepts in social psychology research (Moreland and Zajonc, 1982), implying that similarity might have interesting interactions with other constructs. Such associations have also been proposed in the persona context, so that empathy is facilitated by similarity with others (Bornet and Brangier, 2016); although this proposition has not been empirically corroborated.

We chose to include similarity in the PPS because it can possibly influence other perceptions, for example, so that personas that people perceive as more similar are also liked more. Such effects have been found in the person perception research, defined as the 'similar-to-me' effect (Cotter, 2011), according to which individuals are more likely to respond positively to others that they perceive to be like themselves.

Thus, we leave familiarity and attraction for future research and focus on perceived similarity (see Table 9). Note that perceived similarity can be different from demographic similarity. Perceived similarity is based on how similar the respondent *feels* the persona is. This might not match with the actual similarity between persona and the user in terms of age, gender, and race. For example, despite having different race or age, people can feel a kinship by similar interests (Mastro and Seate, 2012). Because perceived similarity may be a moderator in how individuals perceive the personas, the construct is included in the PPS.

Item 1 is adopted from Reysen (Reysen, 2005) (original item: "This person is similar to me."). Item 2 was adopted from Wittenbaum and Bowman [(Wittenbaum and Bowman, 2004):174] ("My partner and I think alike."). Item 3 was adopted from Tidwell et al. (Tidwell et al., 2013) – the original item ("My interaction partner and I seemed to have a lot in common") was modified to the persona context by emphasizing interests that have been found impactful for persona user perceptions (Salminen et al., 2019, Salminen et al., 2018). Item 4 captures the aspect of value similarity (i.e., sharing values and worldviews) and is inspired by items in Vaske et al. [(Vaske et al., 2007):226].

3.1.4.8. Willingness to use. WTU is a central construct for the adoption of personas in real organizations and use cases (Friess, 2012, Matthews et al., 2012, Rönkkö, 2005). For example, Rönkkö et al. (Rönkkö et al., 2004) report a case where a lot of time was used to create personas that were never implemented in practice. Matthews et al. (Matthews et al., 2012) found that personas had little practical

Table 7
Likability definition and items.

Definition	Item	Reference
Measures how likable the respondent perceives the persona to be.	I find this persona likable.	(Reysen, 2005)
	I could be friends with this persona.	(Reysen, 2005)
	This persona feels like someone I could spend time with.	(Nelson et al., 2014)
	This persona is interesting.	(Baylor and Ryu, 2003)

Table 8
Empathy definition and items.

Definition	Item	Reference
Measures how well the respondent empathizes with the persona.	I feel like I understand this persona.	(Kim and Mutlu, 2014)
	I feel strong ties to this persona.	(Cameron, 2004)
	I can imagine a day in the life of this persona.	(Galinsky et al., 2005)

impact on the work of designers. In a similar vein, Friess (Friess, 2012) found that personas were rarely mentioned in real decision-making situations by designers. Long (Long, 2009) argues that not being part of the creation process can result in not trusting the persona, which is detrimental to their use.

According to Rönkkö et al. (Rönkkö et al., 2004), decision makers are unlikely to take the personas into use if there are doubts about their credibility, which not only implies that adoption of personas is a key concern, but also that individuals' WTU is associated with other perceptions. Even when persona developers are using the best techniques for persona creation, decision-makers may consider personas as 'nice-to-have narratives' instead of serious decision-making aids (Howard, 2015). These findings highlight the risk of personas being forgotten after their creation and emphasize the need for measuring how willing the persona users are to use the persona going forward.

Table 10 displays the items chosen for WTU. Here, we draw inspiration from technology adoption research that often considers willingness to use a system, application, or tool in relation to a specific scenario or task. For example, Gentry and Calantone [(Gentry and Calantone, 2002):951] consider the willingness to use a bot ("If I buy a book in the next 30 days, I predict I would use a shop-bot."), which inspires our Item 1 (see Table 10). Thus, the willingness to use a tool (in this case, a persona) is contextually determined by the user *in situ*. Developing our survey, we created a realistic scenario for the users to create online content (see Section 3.3.3), which represents a practical use case and is reflected in Items 1 and 3. In our context, "using the persona" implies learning more about it for online content creation, which is why we created Item 2 ("I would like to know more about this persona."). Using personas to learn more about users or customers they represent, of course, is one of the core purposes of having personas in the first place (Cooper, 1999).

Item 4 ("This persona would improve my ability to make decisions about the customers it describes") reflects the facet of the persona being useful in terms of enhancing decision-making capabilities and, thus, desirable for use. Personas' goal of enhancing decision-making capabilities is noted by several persona researchers (e.g., (Friess, 2012, Matthews et al., 2012)).

3.1.5. Summary of constructs and items

Table 11 shows the eight PPS constructs and thirty-one items that were used both for the pilot study and the main study. Items dropped due to feedback from experts and pilot test participants are omitted for brevity. Items that are included in the final PPS (after statistical analysis) are shown in Table 15. Note that, when deployed to other situations, the users of the PPS should replace the task in the WTU Items 1 and 3 with one of their own. This is further discussed in Sections 5.2 and 5.3.

3.2. Pilot study

We conducted a pilot study to get feedback on the PPS with 19 participants, each evaluating three personas. The piloting took place at a major research institute among scientists and engineers from various backgrounds. The average age of respondents was 34 years (SD = 6.9). Their roles included Researchers (7), Scientists (4), Software Engineers (2) and Others (6). 15 respondents were male, and 4 female.

We ensured that all respondents were familiar with the concept of personas by verbally explaining the concept. Each respondent evaluated three personas, amounting to [19 × 3 =] 57 persona evaluations. The persona profiles shown to the respondents (see Figure 2) were generated automatically from the social media data from an international media company using the persona generation methodology described in An et al. (An et al., 2018, An et al., 2018).

The pilot study helped us diagnose potential issues with the initial pool of questions based on feedback from the participants. The feedback resulted in some changes in the measurement items, including removal (e.g., "I would enjoy working with this persona" was removed as redundant from likability) and rewording (e.g., repeating the task when referring to it in the items for WTU). After these revisions, the final pool of items was employed in the main study.

3.3. Main study

3.3.1. Analytical roadmap

The analytical roadmap for the main study is as follows. In the first stage, an Exploratory Factor Analysis (EFA) was conducted using the data for one of the personas. An EFA extracts the underlying factorial structure (i.e., dimensions) which encompass the items in the instrument. In a second stage, this structure was tested using a Confirmatory Factor Analysis (CFA), which can be used to confirm the previously obtained structure, but also permits further refinements to the model by falling back to an exploratory strategy. Once a model with acceptable fit is attained, we proceed with calculations on validity (i.e., if the factors are valid measures of the respective constructs), reliability (i.e., if the measures are consistent), and sensitivity (i.e., if the instrument is capable of discerning between distinct individuals). The exercise concludes with an analysis of measurement invariance, which aims to determine if the scale is equally applicable in differing groups – in this case, males and females, as well as experienced and inexperienced users of personas.

3.3.2. Persona generation

To analyze the scale with a larger independent sample, we created two personas (see Figure 3) from audience engagement data of the YouTube channel of an international online media company. The content of the created personas follows the standard layout of persona

Table 9
Similarity definition and items.

Definition	Item	Reference
Measures how similar the respondent feels the persona is to him or her.	This persona feels similar to me.	(Reysen, 2005)
	The persona and I think alike.	(Wittenbaum and Bowman, 2004)
	The persona and I share similar interests.	(Tidwell et al., 2013)
	I believe I would agree with this persona on most matters.	(Vaske et al., 2007)

Table 10
Willingness to use definition and items.

Definition	Item	Reference
Measures how willing the respondent is to learn more about the persona.	I would make use of this persona in my task [of creating a YouTube video].	(Gentry and Calantone, 2002)
	I would like to know more about this persona.	(Cooper, 1999)
	I can imagine ways to make use of the persona information in my task [of creating the YouTube video].	(Hilton and Irons, 2006)
	This persona would improve my ability to make decisions about the customers it describes.	(Friess, 2012)

profiles (Nielsen et al., 2015), containing, for example, demographic information, name, picture, interests, and descriptive quotes. The persona creation followed the approach by An et al. (An et al., 2017, An et al., 2018), in which data is collected using the application programming interfaces (APIs) of online platforms and processed using computational techniques (Lee and Jung, 2019). Thus, the methodology for persona creation was the same as in the study. In between the pilot study and the main study, the system for persona generation was updated, which explains the layout differences between the pilot study (Figure 2) and the main study (Figure 3) personas. Again, for technical details, we refer the reader to An et al. (An et al., 2017, An et al., 2018), as the research at hand focuses on reporting the scale development.

Counterbalancing was applied to mitigate for order effects (see Figure 4). For this, we created two participant sequences: **Sequence 1:** Showing Male persona first, then Female persona and **Sequence 2:** *vice versa*. Note that in between seeing the second persona, the respondents were shown the PPS items (see Table 11), the sequence being: Persona 1 → PPS items → Persona 2 → PPS items.

3.3.3. Data collection and participants

The survey data for persona perception was collected via Prolific, an online survey platform deployed in several social science studies (Duda, 2018, Faily and Flechais, 2011). Prolific provides a large pool of participants and includes built-in quality management tools (Duda, 2018). We sampled participants between the ages of 23–50 from four English-speaking countries: United States, United Kingdom, Canada, and Australia. The targeting criteria resulted in 7,275 candidates from the Prolific pool of participants, of which 412 participated in the study. We provided the respondents a compensation of 1.50 British pounds for their participation, totaling to about a 9-pound hourly work rate.

The average age of the respondents was 33.5 years (SD = 7.10). Females constituted 63% of the sample, males 37%. The sample was well-educated, with 67% of the respondents having an undergraduate degree, 29% a graduate degree, and 4% a doctoral degree. We explicitly exclude non-college educated participants from the Prolific sample, as personas are typically deployed by educated workers (e.g., software developers, designers, marketers). Their nationalities included the United States (31%), United Kingdom (63%), Canada (5%), Australia (1%). The sample included both respondents with no experience in personas (n = 286; 69.4%) and respondents with prior experience with using personas (n = 126; 30.6%). As such, we consider the sample

Table 11
All constructs and items prior to statistical analysis.

Construct	Definition	Items
Credibility	Measures how credible (realistic, authentic) the persona appears.	The persona seems like a real person. I have met people like this persona. The picture of the persona looks authentic. The persona seems to have a personality.
Consistency	Measures how consistent the different information in the persona profile is.	The quotes of the persona match other information shown in the persona profile. The picture of the persona matches other information shown in the persona profile. The persona information seems consistent. The persona's demographic information (age, gender, country) corresponds with other information shown in the persona profile.
Completeness	Measures how well the persona captures essential information about the users it describes.	The persona profile is detailed enough to make decisions about the customers it describes. The persona profile seems complete. The persona profile provides enough information to understand the people it describes. The persona profile is not missing vital information.
Clarity	Measures how clearly the persona information is presented.	The information about the persona is well presented. The text in the persona profile is clear enough to read. The information in the persona profile is easy to understand. The persona is memorable.
Likability	Measures how likable the respondent perceives the persona to be.	I find this persona likable. I could be friends with this persona. This persona feels like someone I could spend time with. This persona is interesting.
Empathy	Measures how well the respondent empathizes with the persona.	I feel like I understand this persona. I feel strong ties to this persona. I can imagine a day in the life of this persona.
Similarity	Measures how similar the respondent feels the persona is to him or her.	This persona feels similar to myself. The persona and I think alike. The persona and I share similar interests. I believe I would agree with this persona on most matters.
Willingness to use	Measures how willing the respondent is to learn more about the persona.	I would make use of this persona in my task [of creating a YouTube video]. I would like to know more about this persona. I can imagine ways to make use of the persona information in my task [of creating the YouTube video]. This persona would improve my ability to make decisions about the customers it describes.

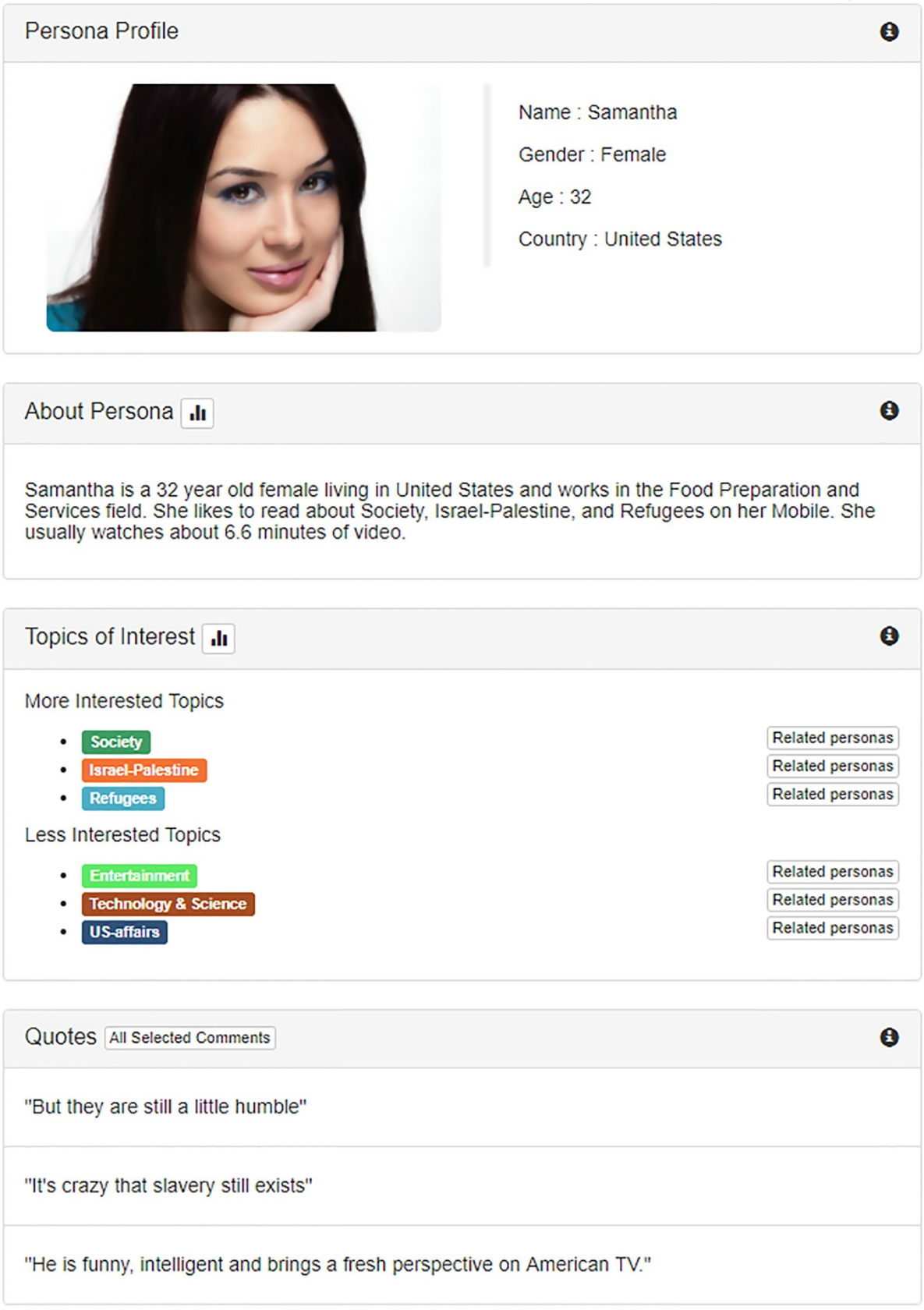

Figure 2. Example of a piloted persona profile. Each respondent was shown three personas. One persona was Asian, one Middle-Eastern and one Caucasian.

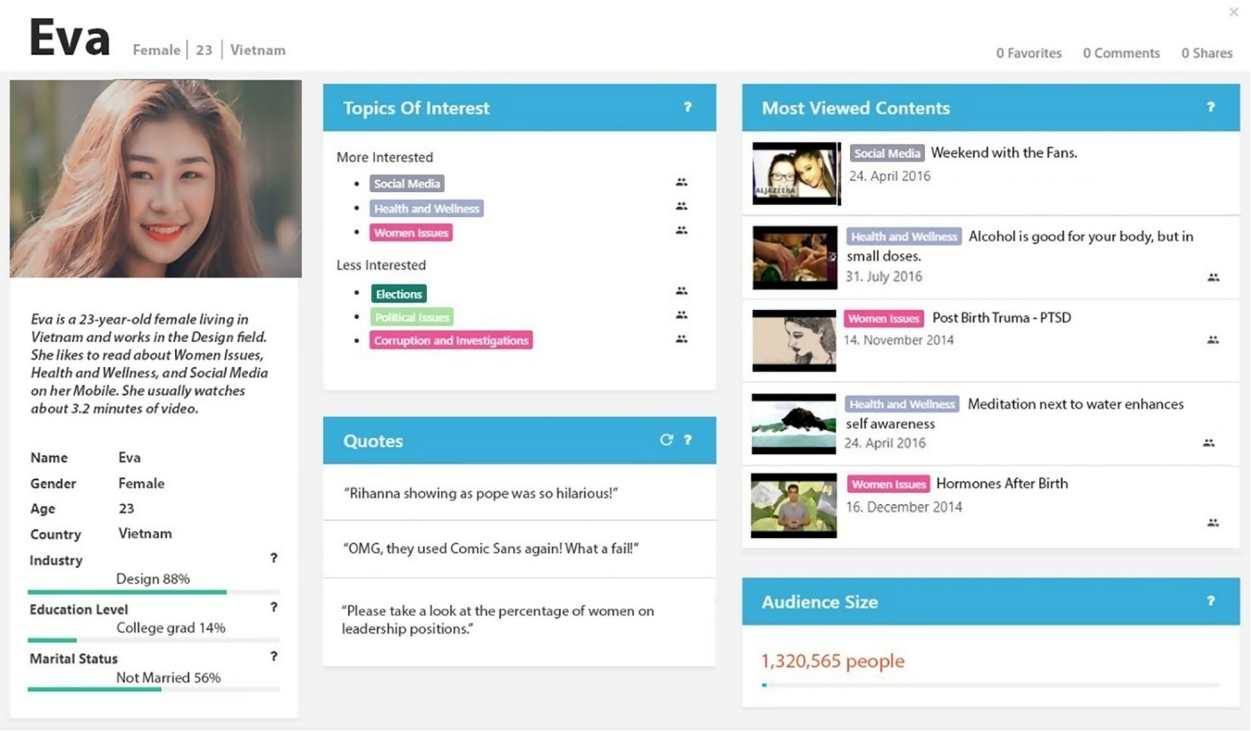

Figure 3. Eva, a persona created for the survey. Another person, Marcus was included so participants saw both a male and female example.

adequately representative for educated adults with varying experience with personas.

In the survey, the respondents were shown the two personas and asked to respond to statements regarding each persona. The statements were created using the PPS items (see Table 11), with answering options using the seven-point Likert scale, ranging from (1) Strongly disagree to (7) Strongly agree. The introduction of the survey contained a definition of personas ("*A persona is a fictive person describing a customer group*."), and the respondents were explained that the purpose of the study is to understand how individuals perceive personas. The respondents were encouraged to review the persona information carefully and give their honest opinions. To facilitate the immersion of using the persona for a specific purpose, the respondents were given a use case that tied the shown personas to a predetermined task, which is a common practice when deploying personas (Banks, 2019). The imaginary task consisted of creating a YouTube video for the persona they were shown: "*Imagine that you are given a task of creating a YouTube video for the persona you will be shown next. Keeping this task in mind, please carefully review the information in the persona profile to understand who the persona is.*" The task of video creation was chosen because creating social media content is nearly universally understandable by individuals engaging in online activities (note that the sample, by definition, includes online users as they were sampled using an online platform).

3.3.4. Data validation

The participants spent, on average, 13.4 minutes (SD = 4.50; max = 36.25; min = 5.11) to complete the survey (including reviewing the two persona profiles). We inspected the data quality by looking at anomalies in the responses using SPSS's "Identify Unusual Cases" module. In addition, we *initially* excluded participants whose answering time was less than 6 minutes, as based on our pilot testing, the survey would take at least this much to be filled. However, we stopped this practice after several of the survey participants contacted us via the platform's messaging system to reconfirm that they actually had filled in the survey in good faith. As they, in many cases, were able to recall specific details about the personas, we concluded that there is a naturally high variation in people's survey answering speed, and that some participants are able to quickly fill in the survey without it necessarily being due to lack of attention. Thus, we found no reason to exclude any participant, so we kept all the 412 responses submitted by the panel of respondents.

4. Results

4.1. Exploratory factor analysis

EFA was conducted on the question pool for the first persona ("Eva") using Principal Component estimation with Direct Oblimin rotation (Abdi, 2003). No missing data was noted in the dataset. Evaluation of data adequacy was assessed as follows: first, normality was judged through each item's skewness and kurtosis. The absolute value for all terms was lower than 3, indicating an acceptable approximation of normality (Kline, 2011), as can be seen in Table 12.

Second, we observed that the Kaiser-Meyer-Olkin (KMO) assumed a value of 0.937, indicating good adequacy, further substantiated by a significant result on Bartlett's Test of Sphericity ($\chi 2(465) = 10688.633$, $p < 0.001$) (Hair et al., 2007, Maroco, 2003). Third, the Measure of Sampling Adequacy (MSA) for each item was above 0.50; as such, no item needed to be removed (Hair et al., 2007). Kaiser's criterion was employed to determine the optimal number of factors, with an auxiliary interpretation based on scree-plots and percentage of extracted variance. These criteria pointed towards a six-factor solution with 72.3% of explained variance. The solution departed, in some aspects, from the predicted structure, which was defined in a preliminary manner through the pilot study (Salminen et al., 2018).

Notably, the items from the Similarity, Empathy, and Likability scale coalesced into a single factor, which we labeled *Immersion* because conceptually this construct encompasses the immersive nature of the relationship between individuals and personas (Chang et al., 2008, Marsden and Haag, 2016, Miaskiewicz et al., 2008, Nielsen, 2013). We considered this a possible indication of a second-order latent structure, in which the original scales would comprise first-order latents. Although not tested at this stage, we noted this finding for testing during

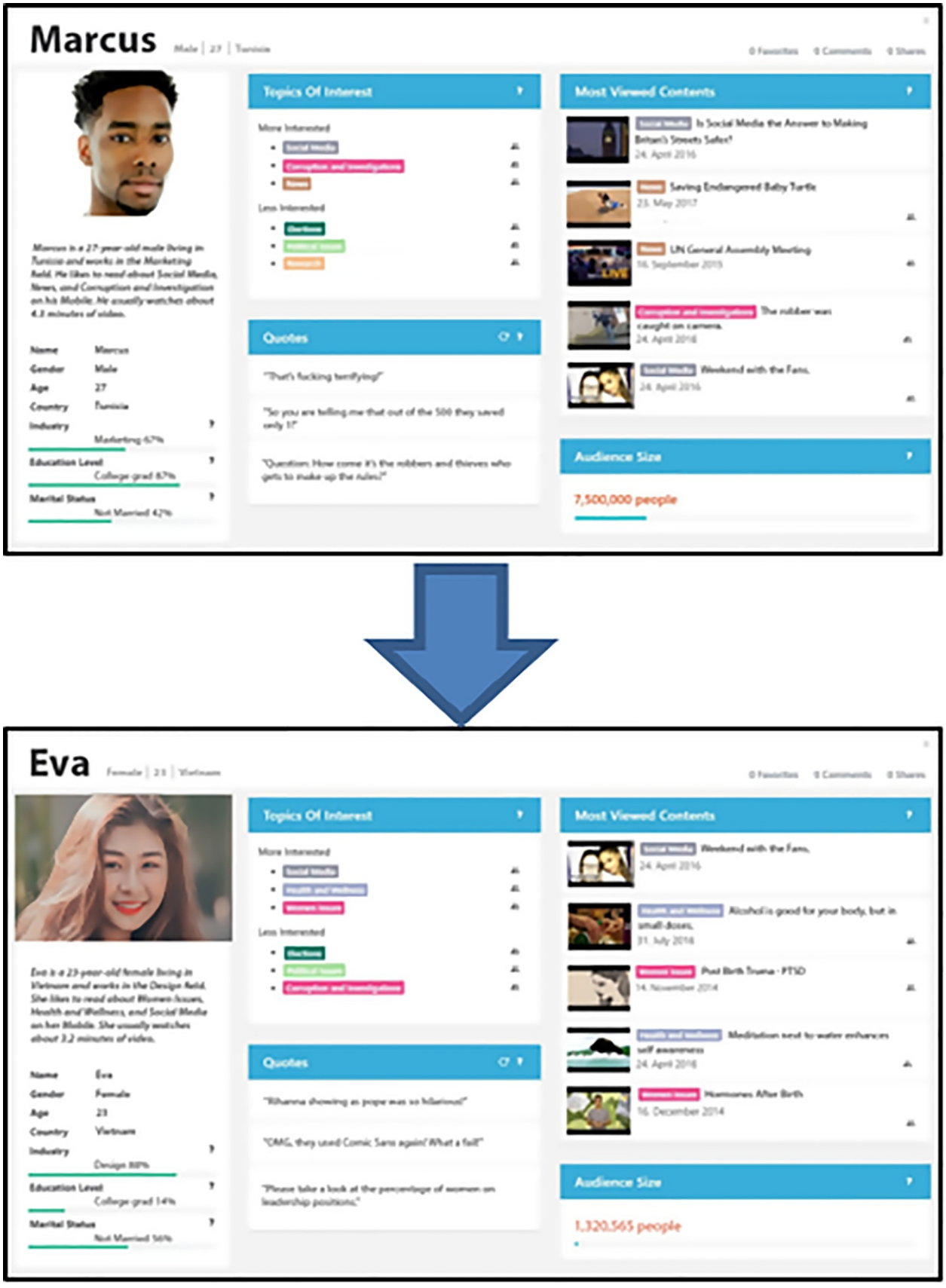

Figure 4. Two personas were shown to participants, assigning the participants randomly to counter-balanced sequences.

Table 12
Descriptives for each item for both personas.

Item	Eva				Marcus			
	M	SD	Sk	Ku	M	SD	Sk	Ku
Credibility1 [The persona seems like a real person.]	5,39	1,34	-1,17	1,31	4,88	1,53	-0,79	0,07
Credibility2 [I have met people like this persona.]	5,17	1,55	-0,95	0,23	4,92	1,64	-0,71	-0,32
Credibility3 [The picture of the persona looks authentic.]	5,37	1,52	-1,10	0,69	5,22	1,50	-1,08	0,71
Credibility4 [The persona seems to have a personality.]	4,76	1,48	-0,49	-0,49	4,64	1,56	-0,54	-0,28
Consistency1 [The quotes of the persona match other information shown in the persona profile.]	4,81	1,46	-0,68	-0,12	4,62	1,51	-0,39	-0,60
Consistency2 [The picture of the persona matches other information shown in the persona profile.]	5,03	1,39	-0,76	0,16	4,77	1,46	-0,63	-0,14
Consistency3 [The persona information seems consistent.]	4,99	1,39	-0,78	0,19	4,69	1,56	-0,52	-0,54
Consistency4 [The persona's demographic information (age, gender, country) corresponds with other information shown in the persona profile.]	4,91	1,48	-0,72	-0,06	4,71	1,49	-0,56	-0,21
Completeness1 [The persona profile is detailed enough to make decisions about the customers it describes.]	4,67	1,48	-0,52	-0,40	4,85	1,46	-0,74	0,15
Completeness2 [The persona profile seems complete.]	4,97	1,49	-0,67	-0,16	4,93	1,44	-0,72	0,06
Completeness3 [The persona profile provides enough information to understand the people it describes.]	4,94	1,45	-0,68	-0,04	4,92	1,47	-0,84	0,06
Completeness4 [The persona profile is not missing vital information.]	4,90	1,42	-0,60	-0,07	4,80	1,53	-0,57	-0,40
Clarity1 [The information about the persona is well presented.]	5,20	1,38	-1,01	0,94	5,38	1,30	-1,07	0,99
Clarity2 [The text in the persona profile is clear enough to read.]	5,16	1,62	-0,89	0,00	5,05	1,56	-0,73	-0,24
Clarity3 [The information in the persona profile is easy to understand.]	5,46	1,36	-1,12	1,23	5,35	1,49	-1,14	0,92
Clarity4 [The persona is memorable.]	4,51	1,65	-0,57	-0,52	4,87	1,46	-0,65	-0,15
Likability1 [I find this persona likable.]	4,40	1,49	-0,45	-0,37	4,18	1,45	-0,38	-0,35
Likability2 [I could be friends with this persona.]	3,67	1,62	0,17	-0,75	3,97	1,47	-0,20	-0,64
Likability3 [This persona feels like someone I could spend time with.]	4,00	1,65	-0,13	-0,84	3,38	1,56	0,20	-0,82
Likability4 [This persona is interesting.]	4,22	1,54	-0,35	-0,55	3,90	1,62	-0,14	-0,86
Empathy1 [I feel like I understand this persona.]	4,20	1,44	-0,34	-0,44	4,12	1,46	-0,34	-0,57
Empathy2 [I feel strong ties to this persona.]	3,50	1,61	0,07	-0,88	3,51	1,54	0,06	-0,89
Empathy3 [I can imagine a day in the life of this persona.]	3,97	1,54	-0,28	-0,64	3,72	1,58	-0,02	-0,84
Similarity1 [This persona feels similar to myself.]	2,82	1,60	0,59	-0,64	2,73	1,48	0,72	-0,15
Similarity2 [The persona and I think alike.]	3,01	1,58	0,42	-0,77	2,94	1,49	0,43	-0,63
Similarity3 [The persona and I share similar interests.]	3,26	1,73	0,27	-1,07	3,15	1,64	0,33	-0,91
Similarity4 [I believe I would agree with this persona on most matters.]	3,39	1,55	0,14	-0,57	3,37	1,51	0,11	-0,54
WTU1 [I would make use of this persona in my task of creating a YouTube video.]	4,38	1,61	-0,51	-0,50	4,29	1,62	-0,38	-0,70
WTU2 [I would like to know more about this persona.]	4,19	1,71	-0,36	-0,82	4,31	1,67	-0,37	-0,75
WTU3 [I can imagine ways to make use of the persona information in my task of creating the YouTube video.]	4,55	1,55	-0,74	-0,06	4,45	1,54	-0,53	-0,46
WTU4 [This persona would improve my ability to make decisions about the customers it describes.]	4,46	1,57	-0,53	-0,34	4,30	1,53	-0,35	-0,57

WTU = Willingness to use

the Confirmatory Factor Analysis (CFA) stage. Moreover, some items exhibited low factorial purity due to moderate to severe cross-loadings into other factors and were removed from the subsequent analysis. These were Clarity_4 ("The persona is memorable"), Credibility_4 ("The persona seems to have a personality"), and WTU_2 ("I would like to know more about this persona"). The remaining items loaded into the expected factors and, as such, the original labels were kept. The rotation solution for EFA is summarized in Table 13.

Subsequently, Cronbach's Alphas were computed for each factor, without the discarded items, to determine scale reliability. All values were relatively high, providing evidence for the reliability of the scale using this factorial structure. These results are summarized in Table 14. After this initial exercise, the analysis proceeded to the CFA stage, which is reported in the following section.

4.2. Confirmatory factor analysis

In this stage, a CFA was conducted using the data from the second persona ("Marcus"). We used Maximum Likelihood (ML) estimation, which is the most common method (Arbuckle, 2007). For the purpose of evaluating model fit, we opted to use the following indices, in accordance with best practices (Bentler, 1990): the χ^2 goodness-of-fit test (Barrett, 2007), the X^2 statistic, the X^2/df index, the standardized root mean residual (SRMR), the comparative-fit index (CFI) (Bentler, 1990), the root mean square error of approximation (RMSEA) (Steiger et al., 1985), and the Akaike Information Criterion (AIC) (Anderson et al., 1998). The strategy for re-specification used Modification Indices (MI) (Bollen, 2014), by specifying covariances between a variable's error terms whenever they belonged to the same latent variable (Galinsky et al., 2005, Hogg and Abrams, 1988) using the threshold value of 11 (Maroco, 2003). The cut-off of 11 was used since it has a Type 1 error probability of 0.001, being the safest option to begin an MI evaluation (note that the commonly used cutoff of 4 represents 0.05 of Type 1 error, and studies usually employ this cutoff as a secondary option after the 11 MIs are exhausted).

We began by specifying the structure obtained at the EFA stage, without the discarded items, and we assumed no second-order structure. This resulted in a model with inadequate fit (X^2/df = 4.540, SRMR = 0.064, CFI = 0.867, RMSEA = 0.090). After evaluation of the MI's, it became apparent that the second-order structure, which we suspected from the EFA analysis was very likely, as the bulk of the MI's indicated the existence of correlations between the error terms for items in the Immersion factor. As such, we shifted back to an exploratory approach, and the first iterative re-specification was conducted by placing the Immersion latent variable as a second-order variable and creating latent variables for each theoretical sub-scale. This change resulted in an immediate improvement of the model fit (X^2/df = 2.822, SRMR = 0.056, CFI = 0.932, RMSEA = 0.064), also noted by the decrease on the comparative index (AIC_{new} = 1084.834 *versus* AIC_{old} = 1663.037). This provided evidence of the presence of a second-order structure for this scale.

We proceeded with re-specification. In the next step, we drew covariance trajectories for error terms belonging to manifest variables lying in the same latent variable, at an MI threshold of 11. This yielded modest gains in terms of fit (X^2/df = 2.708, SRMR = 0.053, CFI = 0.937, RMSEA = 0.062), also evident by the comparative index (AIC_{new} = 1044.926 *versus* AIC_{old} = 1084.834). With no further valid modifications available at the 11 threshold, we proceeded by implementing modifications identified at a threshold of 4. This allowed another set of specification changes under the form of error covariances. This resulted in further improvements to the model (X^2/df = 2.581, SRMR = 0.053, CFI = 0.943, RMSEA = 0.060), again noted by the comparative index (AIC_{new} = 1000.154 *versus* AIC_{old} = 1044.926), now exhibiting acceptable levels of fit. The final

Table 13
Exploratory Factor Analysis with Direct Oblimin (pattern). The highest loading for each item and notable cross-loadings are shown in bold.

	Component					
	1	2	3	4	5	6
Similarity2 [The persona and I think alike.]	0.886	-0.025	0.144	0.062	0.080	-0.103
Similarity1 [This persona feels similar to myself.]	0.880	-0.048	0.135	0.070	0.108	-0.064
Similarity3 [The persona and I share similar interests.]	0.835	-0.045	0.111	0.088	0.078	-0.063
Likability2 [I could be friends with this persona.]	0.810	0.197	-0.171	-0.125	0.066	0.189
Empathy2 [I feel strong ties to this persona.]	0.798	-0.110	0.149	0.020	-0.140	-0.146
Similarity4 [I believe I would agree with this persona on most matters.]	0.795	0.054	0.063	0.150	0.047	-0.075
Likability4 [This persona is interesting.]	0.739	0.025	0.041	0.016	-0.149	0.043
Likability3 [This persona feels like someone I could spend time with.]	0.723	0.050	-0.002	-0.033	-0.027	0.217
Empathy1 [I feel like I understand this persona.]	0.642	0.172	-0.043	0.099	-0.112	0.037
Likability1 [I find this persona likable.]	0.642	0.022	0.006	0.033	-0.086	0.277
Empathy3 [I can imagine a day in the life of this persona.]	0.544	0.104	-0.133	0.057	-0.295	0.051
Clarity4 [The persona is memorable.]	0.349	-0.171	0.288	0.009	-0.319	0.242
Consistency4 [The persona's demographic information (age, gender, country) corresponds with other information shown in the persona profile.]	0.015	0.853	0.036	0.001	0.126	0.058
Consistency3 [The persona information seems consistent.]	-0.017	0.834	0.123	0.071	-0.037	-0.050
Consistency2 [The picture of the persona matches other information shown in the persona profile.]	0.048	0.828	-0.013	0.026	-0.019	0.068
Consistency1 [The quotes of the persona match other information shown in the persona profile.]	0.006	0.691	0.136	0.096	-0.110	-0.069
Credibility4 [The persona seems to have a personality.]	0.144	0.475	-0.179	0.000	-0.398	0.153
Completeness4 [The persona profile is not missing vital information.]	0.048	-0.008	0.780	0.047	-0.055	0.025
Completeness3 [The persona profile provides enough information to understand the people it describes.]	0.106	0.123	0.767	-0.042	-0.073	0.092
Completeness2 [The persona profile seems complete.]	0.096	0.099	0.759	-0.010	-0.061	0.041
Completeness1 [The persona profile is detailed enough to make decisions about the customers it describes.]	0.073	0.123	0.666	0.068	-0.024	0.125
WTU3 [I can imagine ways to make use of the persona information in my task of creating the YouTube video.]	-0.040	0.026	-0.022	0.927	-0.001	0.063
WTU1 [I would make use of this persona in my task of creating a Youtube video.]	-0.008	0.021	0.086	0.872	0.033	0.009
WTU4 [This persona would improve my ability to make decisions about the customers it describes.]	-0.001	0.179	0.055	0.768	-0.025	0.105
WTU2 [I would like to know more about this persona.]	0.344	-0.070	-0.258	0.619	-0.141	0.016
Credibility3 [The picture of the persona looks authentic.]	-0.005	0.060	-0.007	0.027	-0.825	-0.035
Credibility2 [I have met people like this persona.]	-0.033	-0.112	0.173	0.126	-0.720	-0.068
Credibility1 [The persona seems like a real person.]	-0.002	0.221	0.112	-0.021	-0.677	0.127
Clarity3 [The information in the persona profile is easy to understand.]	-0.051	0.014	0.054	0.016	-0.014	0.850
Clarity2 [The text in the persona profile is clear enough to read.]	0.039	0.006	0.001	0.102	0.113	0.818
Clarity1 [The information about the persona is well presented.]	-0.032	0.023	0.246	0.104	-0.117	0.693

model is represented in Figure 5, and the factorial weights presented in Table 15. As re-specification was conducted during this stage, this analysis can no longer be considered confirmatory, but rather an extension of the exploratory analysis. The implications of this will be discussed further ahead in the manuscript.

4.3. Validity analysis

For the validity assessment, three distinct facets of validity were analyzed: factorial validity, convergent validity, and discriminant validity (Hair et al., 2007). Factorial validity requires all items to have a factorial loading above the 0.50 threshold (Maroco, 2003), which was already demonstrated in the previous section. Convergent validity is established when the variance explained by the items loading into a given factor is reasonable, which can be evaluated through calculation of the Average Extracted Variance (AVE) (Fornell and Larcker, 1981) that needs to exceed the 0.50 threshold. For a given factor j comprised of k items i, AVE is calculated as:

$$\hat{AVE}_j = \frac{\sum_{i=1}^{k} \lambda_{ij}^2}{\sum_{i=1}^{k} \lambda_{ij}^2 + \sum_{i=1}^{k} \varepsilon_{ij}}$$

Discriminant validity is established when there is an absence of relevant cross-loadings, and it requires two conditions: the AVE for two given factors must exceed the squared correlation between those factors, and the AVE must simultaneously be greater than the Maximum Shared Variance (MSV) and the Average Shared Variance (MSV) between those factors (Fornell and Larcker, 1981). For the reliability assessment, we used the Composite Reliability (CR) indicator (Fornell and Larcker, 1981), which must be greater than the 0.7 threshold in order to claim the reliability of the scale. For a given factor j comprised of k items i, CR can be calculated as:

$$\hat{CR}_j = \frac{\left(\sum_{i=1}^{k} \lambda_{ij}\right)^2}{\left(\sum_{i=1}^{k} \lambda_{ij}\right)^2 + \sum_{i=1}^{k} \varepsilon_{ij}}$$

Finally, sensitivity is determined when the scale is approximately normal, which requires the skewness and kurtosis of each item to be under the threshold of 3 (Kline, 2011). This aspect was already evaluated during the EFA stage, and it was successfully demonstrated, so it will not be further expanded. The validity and reliability measures were computed using the ValidityMaster module from James Gaskin's Stats Tool Package (Gaskin, 2019). The results are shown in Table 16.

As demonstrated in Table 16, all criteria for the three facets of validity are met. Additionally, the Composite Reliability for all factors is above the required threshold, so the scale can be considered reliable. Sensitivity was demonstrated in the EFA stage. Overall, these metrics indicate that the scale has adequate psychometric properties for deployment.

Table 14
Scale reliability.

	Component					
	1	2	3	4	5	6
Cronbach's Alpha	0.948	0.874	0.877	0.897	0.779	0.819

4.4. Measurement invariance

To demonstrate measurement invariance for gender and experience of using personas, a multi-group analysis was conducted in the manner outlined by Marôco (Maroco, 2003), which consists of the comparison of the unconstrained model (where measurement weights are allowed to freely change across groups) with the fully constrained measurement weights model (where measurement weights are constrained to be identical for both groups), and testing for differences using a chi-square

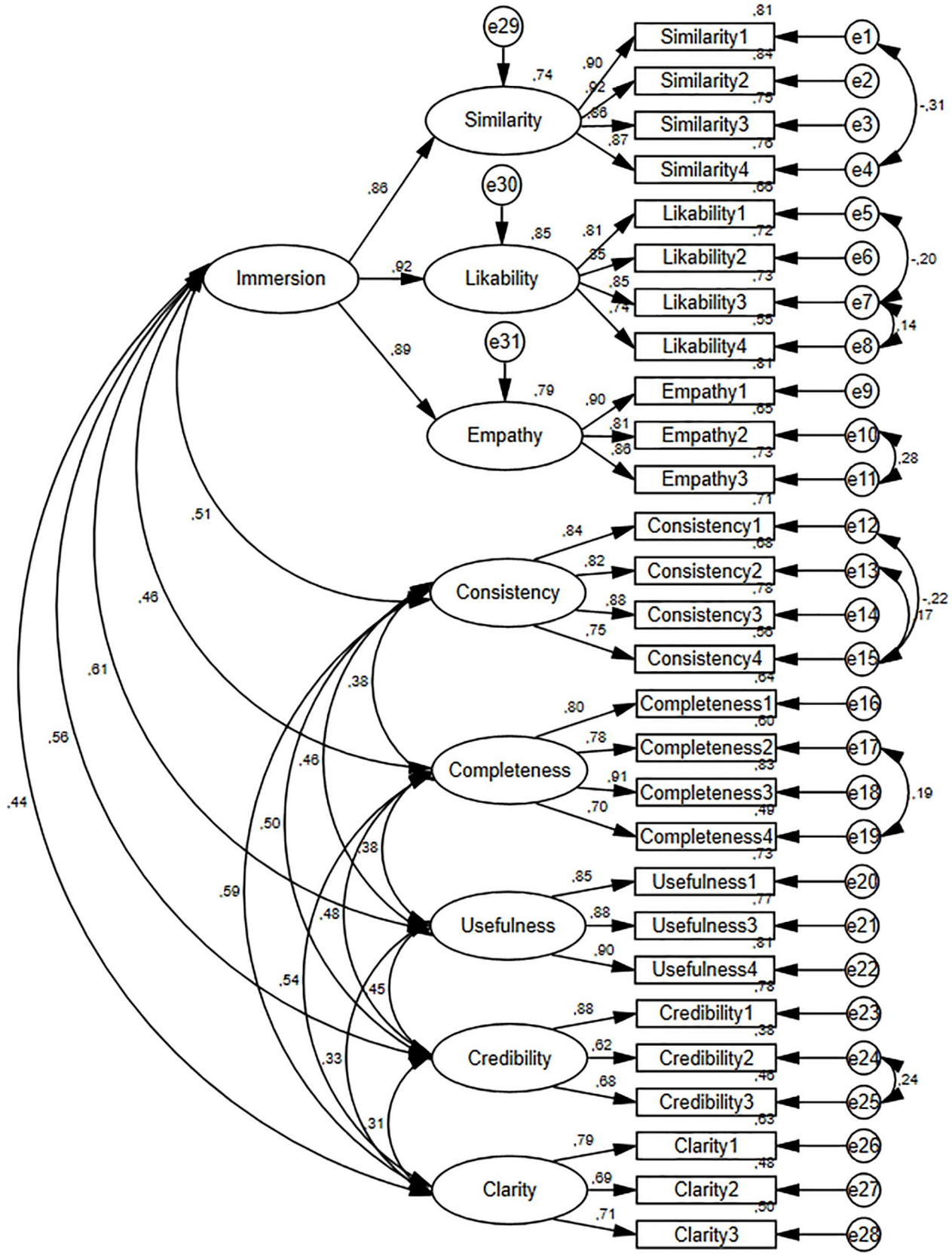

Figure 5. Final measurement model.

test. Non-significance of this test is indicative of measurement invariance across the groups; e.g., the metric for males is identical to the one for females. The chi-square test for the gender comparison was non-significant ($\chi^2(20) = 12.283$, $p = 0.878$). As such, this demonstrates that measurements are invariant across genders. The scale is equally valid for both males and female respondents.

Table 15
Factorial weights of the final list of items.

Item	Item content	Weight
Consistency1	The quotes of the persona match other information shown in the persona profile.	0.843
Consistency2	The picture of the persona matches other information shown in the persona profile.	0.823
Consistency3	The persona information seems consistent.	0.884
Consistency4	The persona's demographic information (age, gender, country) corresponds with other information shown in the persona profile.	0.748
Completeness1	The persona profile is detailed enough to make decisions about the customers it describes.	0.801
Completeness2	The persona profile seems complete.	0.776
Completeness3	The persona profile provides enough information to understand the people it describes.	0.909
Completeness4	The persona profile is not missing vital information.	0.703
WTU1	I would make use of this persona in my task of [creating the YouTube video].	0.853
WTU3	I can imagine ways to make use of the persona information in my task of [creating the YouTube video].	0.880
WTU4	This persona would improve my ability to make decisions about the customers it describes.	0.901
Credibility1	The persona seems like a real person.	0.884
Credibility2	I have met people like this persona.	0.616
Credibility3	The picture of the persona looks authentic.	0.677
Clarity1	The information about the persona is well presented.	0.795
Clarity2	The text in the persona profile is clear enough to read.	0.692
Clarity3	The information in the persona profile is easy to understand.	0.708
Similarity1	This persona feels similar to me.	0.897
Similarity2	The persona and I think alike.	0.919
Similarity3	The persona and I share similar interests.	0.865
Similarity4	I believe I would agree with this persona on most matters.	0.869
Likability1	I find this persona likable.	0.810
Likability2	I could be friends with this persona.	0.849
Likability3	This persona feels like someone I could spend time with.	0.853
Likability4	This persona is interesting.	0.739
Empathy1	I feel like I understand this persona.	0.901
Empathy2	I feel strong ties to this persona.	0.806
Empathy3	I can imagine a day in the life of this persona.	0.857

WTU = Willingness to use

Table 16
Scale reliability (with Immersion).

Factor	CR	AVE	MSV	ASV
Consistency	0.895	0.682	0.342	0.243
Credibility	0.774	0.540	0.310	0.217
Clarity	0.776	0.537	0.342	0.207
Willingness to use	0.910	0.771	0.367	0.207
Completeness	0.876	0.641	0.295	0.205
Immersion	0.920	0.793	0.367	0.268

We also demonstrate measurement invariance for both experienced and inexperienced users. Participants who reported no experience at all were placed in an “Inexperienced” group, with the remaining being placed in an “Experienced” group. The procedure was the same as described above. The chi-square test for this comparison was also found to be non-significant ($\chi 2(20) = 17.630$, $p = 0.612$), indicating that the scale is equally valid for both experienced and inexperienced persona users.

5. Discussion

5.1. Research contribution

Prior research postulates that personas are difficult to evaluate (Madsen et al., 2014). While evaluating a persona in terms of implementation outcomes is difficult, another aspect that is often ignored is the impact of individual perceptions of personas. If we accept the notion that the same persona can be perceived differently by individuals, the logical consequence is that the adoption and usage of personas are affected by these perceptions at an individual level, and the evaluation methods should be individualized as well. Following this rationale, in this research, we undertook the endeavor of developing a survey instrument that is (a) *based on prior research*, (b) *validated in terms of both construct and content validity*, and (c) *can be deployed easily by both researchers and practitioners working with personas*.

As far as the authors are aware, this study marks the first in-depth report of systematically developing a survey instrument for the measurement of persona perceptions. In prior literature, we could locate no existing, publicly available survey instrument for measuring persona perceptions, even though the challenge of evaluating personas is repeatedly referred to. However, contrasting persona perception to person perception opens a rich base of constructs and items from social psychology and HCI research.

From our literature review, the only previous study, apart from the PPS pilot study (Salminen et al., 2018), that makes the linkage between person perception and personas is the study by Marsden and Haag (Marsden and Haag, 2016). However, that study did not develop the idea further, only establishing the conceptual linkage. Our research develops the linkage further by exploring both persona and social psychology domains to create a meaningful array of constructs for analyzing perceptual variance between individuals and personas. We extend the pilot study by Salminen et al. (Salminen et al., 2018) that presented preliminary results on the applicability of the PPS with 19 respondents. In the research reported here, we employ a sample of 412 respondents, conducting an initial exploratory validation of the scale with a robust statistical analysis.

Moreover, compared to the previously reported pilot study, this research reveals a novel second-order latent structure that combines the previously separate PPS constructs of Similarity, Likability, and Empathy into a new construct called Immersion. This discovery is highly interesting for persona theory, as it provides empirical insights on how empathy interacts with other constructs of a related nature. It appears that similarity and likability are strongly associated with empathy to produce the immersive user experience that the persona literature consistently refers to (Cooper, 1999, Nielsen, 2019, Nielsen and Hansen, 2014). This finding encourages further discovery into how different user perceptions interact in the persona context.

Overall, our study adds to a nascent stream of research on perceptual effects of humanlike system and user interfaces, including virtual agents, robots, and chatbots (Edwards et al., 2016, Go and Sundar, 2019, Hasler et al., 2013, Spekman et al., 2018). Similar to

these technologies, personas aim to "give faces to data" (Salminen et al., 2018), providing an anthropomorphic user experience to decision makers dealing with user or customer data.

5.2. Guidelines for scale deployment (general)

Regarding the implications of discovering the Immersion construct, we advise the users of the PPS to choose the constructs that are relevant for their problem. One can choose to measure Immersion, in which case the Immersion items include Similarity 1–4, Likability 1–4, and Empathy 1–3 (see Table 15). However, one can also measure these constructs separately to focus on specific facets of immersion. Both ways are likely to yield interesting insights on how individuals are experiencing the developed personas.

For practical deployment of the scale, researchers and practitioners should use the 28 items reported in Table 15. Moreover, we emphasize the contextual nature of WTU that depends on the particular use case for which the persona is deployed (Cooper, 1999). Therefore, the same persona might be highly useful for one task but not at all useful for another task. For example, decision makers in e-commerce would probably not be willing to use a persona that is missing information about customers' purchase behaviors, whereas the same persona could be highly useful for other use cases.

Some technical recommendations on the instrument's usage follow. First, we would recommend that studies employing the instrument gather a minimum of 5 participants per used item, as this is a commonly used threshold for sample size in factor analysis, and by extension it would be sensible to also employ it in other measurement exercises.

Now that the scale has been analyzed using a large sample, it can be deployed for studies even with smaller samples. This is useful, as user studies in organizations that typically involve fewer participants (e.g., N = 30 is often considered as a goal for data collection (Schmettow, 2012)) can use the scale.

On computing scores for each dimension, we would recommend calculating means. This is for two specific reasons. First, the number of items per dimension is unbalanced, so summation would result in differing ranges of values, which would result in difficult comparisons without some sort of normalization. Second, means are less susceptible to the effects of missing data than summations, since the maximum possible range value is affected in the latter but on the former. On the interpretation of these scores, all dimensions are framed in a positive manner, so they are read in a "higher is better", so that higher scores are indicative of a higher loading of a given perception of the persona.

Due to this consistency of dimension framing, coupled with the fact that there is some degree of correlation between the dimensions, one can argue that a mean of all composite scores can be construed as a measure of *persona quality*. This applies with some restrictions, mainly that the design goal of personas does not include making them "likable" or "similar than the person using them" (two constructs of the PPS). To the contrary, "unlikable" and "different than me" personas can be more useful in many decision-making scenarios, especially since they help steer away from the users' self-centering bias (Salminen et al., 2018). Thus, to measure persona quality, we recommend using Credibility, Consistency, Completeness, Clarity, Empathy, and WTU, so that *a "good" persona would be perceived by its user as credible, consistent, complete, clearly presented and empathetic, such that decision makers would be willing to use it for their work tasks*.

Thus, one can argue that the higher the scores are, the better the overall quality of the persona (apart from likability and similarity that we do not consider as quality dimensions). Providing definite cut-off points for "low" and "high" persona quality requires more repetitive studies across different contexts and scenarios and then using empirical distributions (e.g., interquartile range) to infer the cut-off points from data. Another option would be to heuristically divide the Likert scale into roughly even quality ranges. For example, 1-2 = low quality; 3-5 medium quality, and 6-7 high quality personas. These efforts can enable practitioners and persona developers to determine a global "persona quality score". For this, we recommend that practitioners use the raw composite score, i.e., 1-7, as discretizing variables into dummies is associated with loss of information (as various degrees of response are "flattened down" into one).

5.3. Guidelines for scale deployment (practitioners)

The research has implications for persona researchers, persona creators, and industry practitioners. Practitioners can survey the end users of personas to understand how the developed personas are perceived by the end users, such as marketers, product managers, software developers, corporate executives, and so on. To provide further guidelines into scale development, we describe four use cases.

Pre-testing personas: A potentially impactful use of the scale is to pre-test personas for perceptions before deploying them into wider use within an organization. For example, the PPS could be deployed to analyze how the perceptions of decision makers affect the actual decisions taken about the users or customers of an organization. This is an important point to address, as decision makers' perceptions of different customer groups may lead to favoritism or prioritization of one group over another (Gabbidon and Higgins, 2007). For pre-testing, particularly important constructs are Empathy (Immersion) and WTU, as these constructs are conceptually associated with the adoption of personas for real use.

Querying decision-makers' stereotypes about users: The PPS can reveal one's attitudes towards a persona (i.e., the underlying user segment). Thus, the deployment of the PPS can be associated with the equal and fair treatment of users and customers, for example, by investigating the implicit biases associated with a set of personas. Additionally, conflicting views of the persona can arise despite being shown the same persona information, which can potentially invalidate personas as effective design tools (Rönkkö et al., 2004). To address this, the PPS can help identify situations in which different teams or individuals are interpreting the personas differently. The results can be leveraged towards the creation of personas that produce less variability in perceptions –v thus, helping to align decision makers' understanding of their users.

Persona failure analysis: Moreover, with the PPS instrument, the created personas can be tested for undesirable effects, such as lack of credibility and consistency. If a persona profile or narrative is considered untrustworthy or inconsistent, this implies the design goals for persona creation have not been achieved. Such verification is particularly important because the creation of personas tends to require major financial investments in tens of thousands of US dollars (Howard, 2015), which means that persona developers want to mitigate any barriers to persona adoption and use. As active use of personas remains a consistent challenge, systematic methodologies such as the PPS can help create solutions for adoption.

Longitudinal analysis of attitudes towards personas: Finally, the PPS instrument can be employed to measure the change in persona perceptions over time, considering, e.g., the impact of seemingly minor changes to persona profiles, which could result in major changes in the perception of those personas by the end users. By quantifying the perceptions with the PPS, it is possible to measure the *consistency* of persona perceptions over time, even when the persona undergoes radical changes. Such an analysis is highly called for, as the field of persona research is in dire need of longitudinal studies of persona use in real organizations (Friess, 2012), and the quantitative measurement of persona perceptions provides a proper toolkit for researchers to conduct longitudinal research.

Iterative improvement of personas: The PPS can be used as a part of an iterative process to improve persona designs. This works as follows. We first deploy the PPS to map potential issues with the persona design (e.g., low credibility rating). Using the PPS, practitioners can gain awareness of the perceptual problems with the persona design (as

Table 17
Ideas for improving the perceptual dimensions of personas.

Improve…	By…
Credibility	• ensuring personas are based on real user data (An et al., 2018) • triangulating data source such as quantitative and qualitative, behavioral and interpretative (Pruitt and Grudin, 2003)
Consistency	• ensuring information elements in the persona match one another (Chapman and Milham, 2006)
Completeness	• investigating the information needs of persona users (Nielsen and Hansen, 2014)
Clarity	• following conventions of persona information design for content and layout (Nielsen et al., 2015)
Empathy	• involving "depth" and personal details of the persona (Cooper, 1999)

they can be quantified) and then, using qualitative inquiry, work towards solving them (Table 17 provides some ideas). To support iterative improvement, the PPS can be administered on several occasions – for example, in an iterative design loop like this: *use the PPS to find out credibility is low → use qualitative interviews to find out why → make changes to persona design → repeat the PPS and see if the credibility score has reached a satisfactory level.* Thought from this angle, "How to make high-quality personas?" is an empirical question, or rather a design journey, for which the PPS provides an instrument.

Regarding the feasibility of deploying the PPS in terms of answering fatigue, in our study, the respondents spent an average of 13.4 minutes to complete the survey (including reviewing the two persona profiles). The PPS contains 28 items, which can be considered as a reasonable number. Although practitioners are busy in the field and for that reason a minimal answering time is recommended, the average time of completing the PPS survey can be judged to be reasonable, especially considering the major financial investment that many organizations make when commissioning persona development projects.

Finally, we again emphasize that the WTU is associated with the work task scenario at hand. The PPS was validated by testing a scenario of online content creation (i.e., a YouTube video). When deployed in organizations, the administrators of the PPS should use a task that represents a real or realistic work task scenario in their context.

5.4. Guidelines for scale deployment (researchers)

As examples of how the PPS could be deployed in research, we mention research questions where the scale has either been deployed or is planned for deployment:

- How does increased persona transparency affect persona perceptions? (in review)
- How does using a smiling vs. non-smiling picture in the persona profile affect persona perceptions? (Salminen et al., 2019, Salminen et al., 2019)
- How does the use of toxic quotes shape persona perceptions? (in review)
- What is the relationship between persona perceptions and users' relationship with the persona over the long term? (planned for deployment)
- How does experience with the specific task affect perceptions, such as the willingness to use the persona? (planned for deployment).

Researchers can creatively develop similar questions to systematically test how (a) various manipulations in the persona profile's content/layout, as well as (b) persona user characteristics (e.g., age, gender, similarity with the persona) affect an individual's perceptions of personas. This inquiry can take place by combining experimental persona designs (i.e., changing a variable in Version B, while keeping Version A constant). For example, in on-going research, we use a hate detection algorithm to remove toxic comments from personas automatically created from social media data, and then examine how toxic vs. non-toxic personas are perceived by individuals.

Experimental results can be combined with qualitative methods, such as think-aloud (Salminen et al., 2018), to understand both *how* and *why* individuals perceive the persona as they do (e.g., uncovering their biased thinking). Qualitative data collection can take place simultaneously with the use of personas, or after administering the PPS and analyzing its results. In the latter case, the PPS results can shed light into what directions the qualitative inquiry should proceed in a quest of gathering deep insights about persona perceptions.

The PPS can also help uncover individual differences in their attitudes towards personas. Consider this example scenario. *Persona User 1*, for whatever reason (perhaps the information is not matching his stereotypical view of the customers), does not like *Persona A* and is not willing to use this persona when making decisions. This is a case of non-adoption; i.e., *User 1* refuses to accept the persona.

In turn, *Persona User 2* thinks the opposite; she likes the persona and is willing to use it. Now, given that we have the PPS as an instrument, we can quantify *both* the aggregated view (composite score) of the credibility, WTU, etc., of the persona throughout the organization, *and* the variation of these perceptions by individuals. The variation in itself can be crucial for enhancing systematic adoption of personas in organizations, a longstanding issue in persona theory and practice (Chapman and Milham, 2006, Rönkkö et al., 2004).

Finally, we want to highlight the possibility of partial use of the scale – depending on the research questions, it may not always be purposeful to deploy all constructs of the PPS in a given study. Thus, researchers can focus on a subset of them. As an example, this was done in a study by Salminen et al. (Salminen et al., 2019) that selected four constructs from the PPS to investigate how smiling in persona pictures affects user perceptions.

5.5. Limitations and future research avenues

As any research, our analysis involves certain limitations. One limitation is that the sampling of the study did not consist entirely of professionals with experience in using personas in their work. While all the participants in the pilot study had a basic understanding of personas, it was not specifically ensured that they use personas in their jobs. It is possible that a respondent who has never encountered a persona would have different general responses to personas as people who actually use them to make decisions. However, at the same time, many of the constructs included in the PPS, such as likability and empathy, can be considered as universally applicable to individuals, as anyone can *perceive* a persona as another *person*. From this aspect, it is possible that individuals' perceptions of a persona are based on other reasons than their familiarity with personas, such as personal history, racial stereotypes, gender stereotypes, etc. In fact, previous persona research supports this proposition (Hill et al., 2017, Marsden and Haag, 2016).

Therefore, our results are to be taken indicative of how *individuals generally* perceive personas, rather than necessarily reflecting how *end users of personas* perceive personas. It is uncertain if the perceptions of end users of personas and those of individuals without experience in personas quantitatively differ from one another, although there is evidence that a designer's experience and skills influence their perception (e.g., when reading sketches (Menezes and Lawson, 2006)). Whether this applies to the reading and interpretation of personas is an interesting question for future work to address.

Another aspect that was not controlled in the study but that might affect the results is task experience. For example, a complete novice in social media content creation could approach the given task differently than a professional and might be differentially influenced by the persona. As stated, the participants' experience with social media content creation, and specifically that of YouTube video creation, was not controlled. Rather, we assumed a base level of experience in social media content creation, given that the respondents were recruited from an online pool of participants that suggest a higher-than-average proficiency with online activities. Nevertheless, the fact of not controlling for content creation experience is a deficiency in the current study; future work should take this matter into consideration and measure the respondents' task experience in addition to their experience with personas.

It can be stated that we investigated the "first-moment perception" of two persona profiles. In HCI design contexts, personas are often used over a longer period and in a collaborative way (Friess, 2012). It is also possible that individual beliefs about personas change over time. Interestingly, the PPS could be very useful in longitudinal studies to test if, when quantifying persona perceptions at different points in time, persona users' perceptions toward a persona change. If so, this could be a key finding in addressing whether individual users form cognitive relationships with personas, and under which circumstances. Extant persona research has not demonstrated this is a rigorous way. Thus, addressing this issue exemplifies how the PPS can be used for gaining novel ground in persona research.

Moreover, note that only two personas were used in the study; replication studies with different persona designs (alternating information content and layouts) could produce deviating results. The major advantage is that the PPS scale affords the testing of such effects; for example, we could modify the layout keeping persona information constant, and explore if persona design choices have an impact at a perceptual level. Using the PPS to investigate the dynamics between persona information content and its presentation thus provides interesting research avenues. Nonetheless, not that the persona template tested here corresponds with the conventional information and layout of a persona that includes a profile-like presentation with name, picture, text description, and miscellaneous other information (Nielsen et al., 2015).

Regarding the technical aspects of the scale validation, acceptable threshold values are rarely set in stone. Indeed, other equally valid references indicate other cut-off points. Some of the items exhibited cross-loadings that could have justified their removal. However, this matter is somewhat judgmental, as different sources recommend different threshold values. For example, Hair et al. (Hair et al., 2009) indicate that only loadings of 0.50 and above are considered practically significant. Furthermore, if the crossloadings were truly problematic, the issue would have manifested itself at the CFA stage during the Modification Indices evaluation – where it would manifest as a MI with massive gains through cross-loading – however, this did not occur.

As for the fit indices obtained in our study, it is possible to find cut-off points in the literature that are at the very highest of thresholds. Although these are seen on occasion in practice, they are quite difficult to reach with larger models due to their complexity. Notably, most authors indicate gradients of fit quality. For example, Marôco (Maroco, 2003) suggests that CFI becomes minimally acceptable after 0.8, good at 0.9 − 0.95, and very good past that point. Likewise, the same author considers RMSEA to have a good fit at 0.05 − 0.10. Other authors consider 0.08 as a potential cut-off value (Browne and Cudeck, 1992). Thus, there is no clear consensus on the optimal cut-off point. Overall, we are confident that the psychometric properties of the scale that we obtained are adequate for deployment of the scale on the field.

An equally important consideration is that the structure of the scale was modified in a post-hoc manner during the CFA stage. The implication of this is that the Confirmatory Factor Analysis ceased to be entirely confirmatory at this point. Thus, although our data presents substantial evidence on the psychometric properties of the scale, the model needs to be tested exactly as it is against a fully independent sample, in order to obtain a truly confirmatory analysis.

Regarding future research, it would be imperative to test models that use the other perceptual constructs to predict WTU, as this construct is conceptually the closest to adoption and use of personas, both identified as major challenges in the field (Chapman and Milham, 2006, Matthews et al., 2012, Rönkkö et al., 2004). In other words, what explains the willingness to use a persona? Second, we propose investigating the relationships between the perceptual constructs and the *actual* use of personas within organizations and teams. This effort would help us understand what type of perceptions best influence the use of personas in professional empirical settings.

For these efforts, it is imperative that the relationships of the PPS constructs are further examined. For example, likability and similarity are very relevant constructs because of their potential mediating/moderating effects in relation to the other constructs. For example, decision makers could potentially be more willing to learn more about personas they perceive as more likable or more similar to themselves (identification effect (Hogg and Abrams, 1988)). It is these kinds of effects that we want to further explore using the PPS in future research, to better understand the relationships between different persona perceptions and how they, in aggregate, influence the organizational adoption and use of personas.

Finally, discovering other constructs from social psychology and HCI represents itself as a potentially fruitful endeavor. For example, perceptions have been measured in a large array of research on virtual agents (Hasler et al., 2013), human-robot interaction (Mara and Appel, 2015, Spekman et al., 2018), and chatbot interfaces (Araujo, 2018, Go and Sundar, 2019). These studies are phenomenologically similar to persona research because the research in these domains intends to capture user interaction with artificial, human-like entities. Those entities are similar to personas in the perceptual sense, i.e., in that their users attribute human qualities to them. For example, regardless whether the user is a consumer using a chatbot or a designer using a persona, attitudes like empathy can matter for making use of that entity. To this end, interesting constructs for further exploration could include curiosity (interest), attractiveness, and personality traits. This research, although performing an extensive literature review, was limited in its ability to consider all possible constructs available in the field of social psychology and HCI.

6. Conclusion

We present and conduct an exploratory validation of a survey instrument for measuring individuals' perceptions of personas, addressing the widely acknowledged need for persona evaluation methods. Our PPS instrument is based on an extensive literature survey, tested for validity and reliability, and readily deployable by researchers and practitioners, including persona creators. Overall, this research represents a step toward the quantitative evaluation of personas. Earlier research has established that persona perceptions, such as credibility and consistency, are critical for the adoption and use of personas. Therefore, the existence of a standard instrument to measure the perception of personas has value to the persona research and to those who employ personas in their work.

CRediT authorship contribution statement

Joni Salminen: Conceptualization, Validation, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization, Supervision, Project administration. **Joao M. Santos:** Methodology, Software, Validation, Formal analysis, Writing - original draft, Writing - review & editing, Visualization. **Haewoon Kwak:** Conceptualization. **Jisun An:** Conceptualization. **Soon-gyo Jung:**

Conceptualization, Resources. **Bernard J. Jansen:** Conceptualization, Resources, Writing - original draft, Writing - review & editing.

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