Reconceptualizing the Persona Perception Scale for Non-Human Personas: A Formative Validation Study

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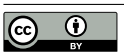
Abstract

Researchers and practitioners are creating *non-human personas* to make non-human entities' proverbial "voice" visible for decision-making. However, instruments for evaluating persona quality are typically based on person perception and social psychology, making them unsuitable for measuring how users perceive these non-human personas. In this study, we propose a reconceptualization of the Persona Perception Scale (PPS), which is a commonly applied instrument for evaluating individuals' perceptions of personas, as the original PPS constructs assume anthropocentric evaluative norms that do not necessarily transfer to non-human personas. We propose a modified version called Non-Human Persona Perception Scale (NH-PPS) that uses constructs that should be more applicable to user perceptions of non-human entities. We develop NH-PPS constructs and candidate items through conceptual analysis and expert review and conduct a formative evaluation with 24 participants interacting with two non-human personas. We present the theoretical rationale for each construct, provide candidate items, conduct a formative evaluation of the scale, and discuss its implications for the design and evaluation of non-human personas in HCI research and practice.



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NordiCHI '26, Vaasa, Finland
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ACM ISBN 979-8-4007-2373-5/26/10
https://doi.org/10.1145/3829807.3829855

CCS Concepts

• **Human-centered computing** → **Interactive systems and tools**; **HCI design and evaluation methods**.

Keywords

non-human personas, more-than-human design, scale development, persona perception

ACM Reference Format:
Joni Salminen, Lene Nielsen, Farhan Ahmed, Trang Thi Thu Xuan, Rajat Patil, Ilkka Kaate, Danial Amin, and Bernard J. Jansen. 2026. Reconceptualizing the Persona Perception Scale for Non-Human Personas: A Formative Validation Study. In *Proceedings of the 14th Nordic Conference on Human-Computer Interaction (NordiCHI '26), October 03–07, 2026, Vaasa, Finland*. ACM, New York, NY, USA, 19 pages. https://doi.org/10.1145/3829807.3829855

1 Introduction

Personas, fictional yet data-grounded archetypal humanized representations of user groups, are a staple method in human-centered design (HCD) [11, 22], a subfield of human-computer interaction (HCI). Originally conceived as tools for making abstract user data relatable and actionable for design teams, personas provide a narrative anchor: a named character with goals, frustrations, and context that designers can reference when making design decisions [43]. Considerable effort has been put into both the refinement of the persona method and the development of instruments to evaluate the quality and effects of personas [50]. One of the most commonly applied instruments is the *Persona Perception Scale* (PPS) [54], which measures user perceptions of personas through constructs such as

consistency, completeness, and empathy (see the constructs and items of the PPS in Appendix A).

However, while personas have been widely applied in HCD, the boundaries of who or what can be represented by a persona are expanding. A growing body of work in more-than-human design [12, 19, 62], multispecies HCI [37], and environmental informatics [17] has explored the creation of personas for non-human entities [2], such as animals, plants, ecosystems, and even abiotic environmental features such as rivers or soils. The motivating insight behind these efforts is that design and policy decisions, especially those related to sustainability actions, may affect non-human species, yet the standard toolkit of HCD systematically omits non-human stakeholders from the design process. Non-human personas attempt to address this omission by translating ecological and biological knowledge into a representational form that human decision-makers can engage with. A non-human persona can be a named entity with needs, vulnerabilities, and relationships that can be placed alongside human personas in design workshops, planning exercises, and stakeholder analyses (see example in Figure 1).

Non-human personas can possibly be highly beneficial from multiple perspectives. First, they can generally increase the prospect of considering non-human voices in the design and decision-making processes involving ecological or other non-human considerations. Second, non-human personas can make otherwise invisible or hard-to-understand ecological costs and interdependencies tangible to human decision-makers, thus contributing to United Nation's sustainable development goals (SDGs[1]), which are increasingly considered relevant for HCI research [23]. Third, non-human personas could affect a broad range of stakeholders including but not limited to designers and key decision makers involved in creating products, policies, processes, but also end-users, for example, consumers among whom non-human personas could increase awareness, while alleviating fears and stereotypes related to specific species (e.g., wolves being bad [56]) and nudge more environmentally friendly consumption choices.

Consequently, if we accept the premise that non-human personas could be of value, then the logical next question is, "What kind of non-human personas should we create?". For example, research has found a charismatic species bias [40], postulating that species that people find more approachable garner disproportionate attention, funding, and conservation effort relative to less glamorous but often equally or more ecologically important organisms. If we strive to mitigate such biases in human-to-human interaction, should we not do the same when representing various non-human entities as personas for decision making? If the response to this rhetorical, yet important, question is affirmative, then we might by conjecture accept the premise that measuring how humans perceive non-human personas plays a central role in the adoption, use, and utility of non-human personas. For example, we could compare two versions of non-human personas depicting bees and compare which version is perceived *more favorably* by people making decisions that affect the living conditions of bees.

[1]For example, Life on land (SDG 15) and Life below water (SDG 14) are relevant for non-human design.

However, this raises a measurement challenge. What does "more favorably mean"—more broadly, what perception attributes of non-human personas should we measure and how? To this end, the HCI community can provide answers, rooted in previous work on *persona perception* [54]; i.e., how users perceive human personas, but as per our knowledge, no research has investigated the perception of non-human personas.

If non-human personas are to be taken seriously as design tools, we need ways of evaluating whether non-human personas can (a) represent a species' situation accurately (that is, factually), (b) translate into meaningful considerations of non-human interests, and (c) influence decision-making outcomes. However, existing measurement scales and survey instruments, such as the PPS, were developed for purely HCD evaluation. Such constructs are based on the notion of a person's perception of a human persona, which deals with how people perceive other people [54]. For example, in PPS, credibility is measured as "seems like a real person," empathy is based on interpersonal identification, which lacks conceptual validity when applied to non-human personas.

However, the deeper issue is that the PPS embeds evaluative norms that are not only inapplicable to non-human personas but potentially counterproductive for non-human design. For example, a non-human persona that scores high on "seems like a real person" (credibility in PPS) or "I could be friends with this persona" (likability in PPS) may be succeeding as an anthropomorphic fiction while failing at its actual purpose of representing an entity whose existence is *fundamentally unlike human existence*. In the worst case, a scale built on human-centric constructs would systematically reward the distortions that non-human personas should avoid.

Against this backdrop, in this research, we critically examine the PPS and propose a reconceptualized instrument, which we call the **Non-Human Persona Perception Scale (NH-PPS)**. The NH-PPS is designed to evaluate user perceptions of non-human species personas or, more broadly, *non-human entities* that can cover different types of animals but also other living organisms, such as plants and bacteria, as well as non-living things (e.g., AI agents and robots). Our contributions are as follows. First, we provide a conceptual analysis of why the original PPS constructs do not transfer to the non-human persona context. Second, we propose the NH-PPS that includes reconceptualized constructs from the original PPS and newly introduced constructs, along with candidate items. Third, we conduct a formative evaluation study of NH-PPS with 24 participants interacting with two non-human personas (more details in Section 3). Finally, we discuss the implications of the NH-PPS for the evaluation of representational devices that aim to give voice to non-human stakeholders.

Regarding the scope of work, our empirical study should be read as a formative feasibility assessment and early exploratory validation, rather than as a conclusive psychometric validation. With this caveat in mind, we proceed to laying out the conceptual foundations of this work.

2 Related Work

Figure 2 presents the conceptual underpinnings of this work. The following subsections expand on these concepts in line with the related HCI literature.

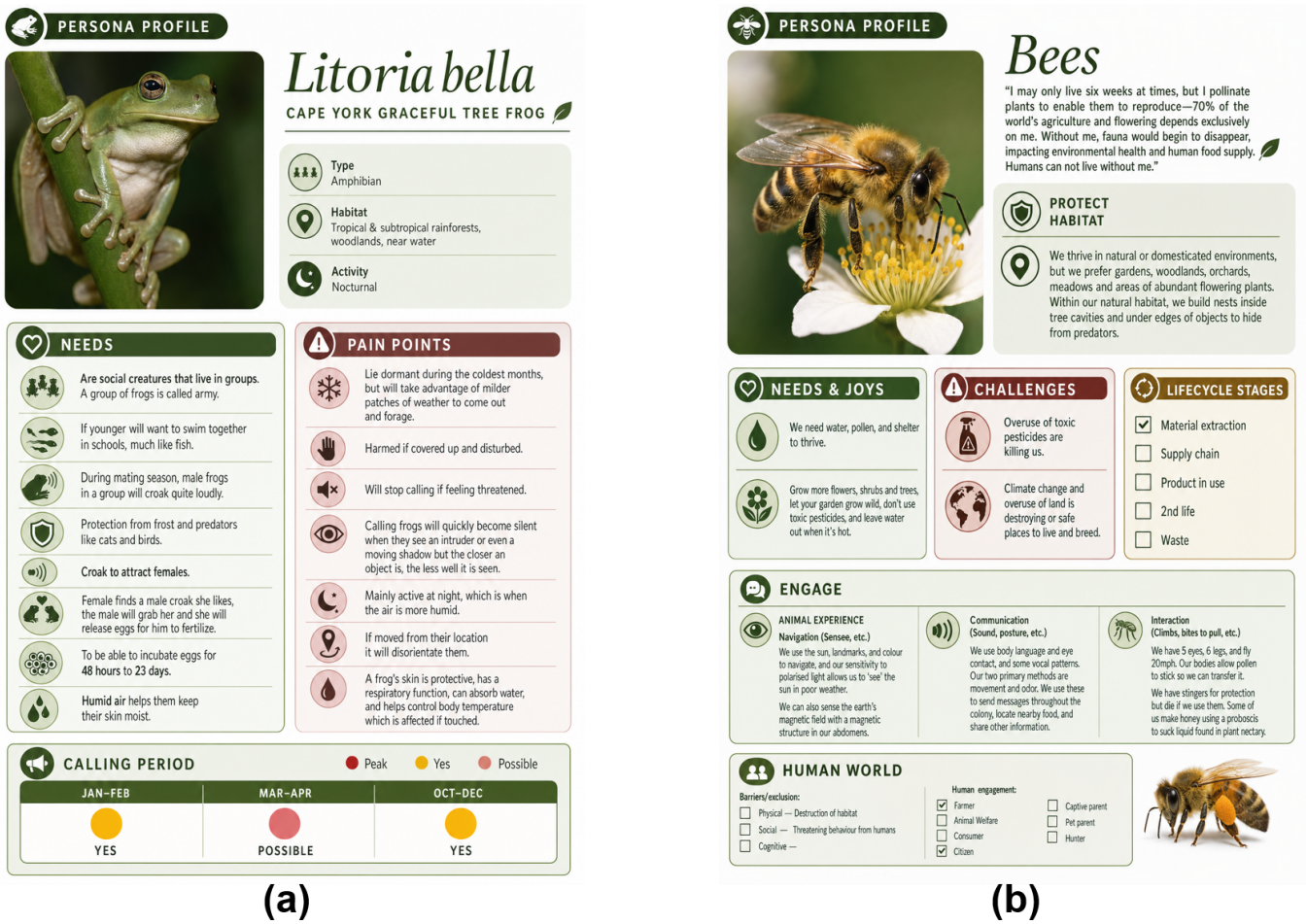


Figure 1: Examples of non-human personas: (a) an excerpt of *Litoria Bella*, a persona created in a collaboration project between IBM and the Australian Museum that included frogs as non-human stakeholders to design a citizen science app for increasing awareness about the protection of frog species in Australia [59]; and (b) a persona for bees created by Damien Lutz for the World Design Congress in 2022. The reader is encouraged to zoom in for better legibility. Note: the images have been recreated using GPT-Image-2 (August 2026) from information extracted from the original persona profiles.

2.1 Personas in Human-Centered Design

The persona method, which involves presenting information about target groups to designers, was popularized by Cooper [11] as a HCD method. A persona is often presented as a profile consisting of a name, an image, demographic details, behavioral patterns, goals, and a brief narrative that situates the character in a realistic context [43]. The purpose is to make abstract user data relatable and memorable [46], thereby helping design teams maintain focus on real user needs rather than designing for themselves or for a vaguely imagined "average user" [42]. In addition to profile personas, dialogue- or chat-based personas have become common in the wake of artificial intelligence (AI) technologies [1, 3, 53] that now enable AI to assume the role of the group represented by the persona. This means the study of how users perceive personas needs to account for chat- and profile-based interaction.

Persona research has addressed their development from both qualitative [20] and quantitative data sources [65], their effectiveness in design practice [35], and persistent critiques of their empirical grounding and potential for stereotyping [60]. A recurring concern is that personas, as narrative constructions, may introduce biases and stereotypes, particularly when the persona creator's assumptions about a user group lack empirical grounding [34, 60]. Therefore, many of the issues with personas deal with how stakeholders perceive the personas they are using, for which reason a key persona validation mechanism, in addition to statistical validation metrics [7, 14], are survey-based evaluation instruments, also referred to as scales [13].

2.2 More-Than-Human Design and Non-Human Personas

The extension of design methods to account for non-human stakeholders has gained momentum in several streams of literature within and related to HCI. These include at least more-than-human

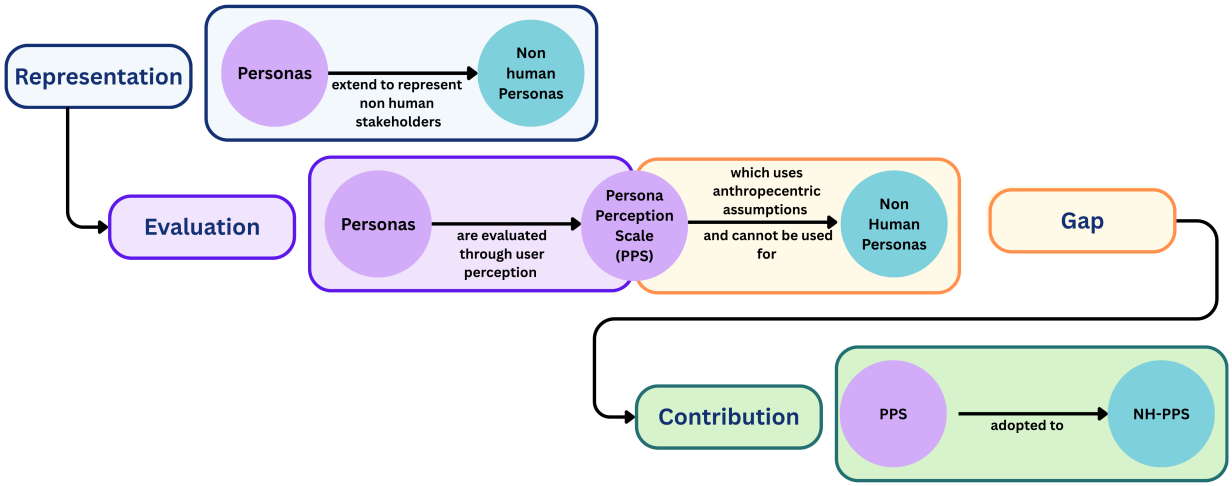


Figure 2: The conceptual underpinnings of this work. 1. Personas are valuable user representation instruments in HCI. 2. However, they focus on human users, so we need non-human personas to represent non-human stakeholders, such as animals and nature. 3. Regardless of what personas are used for and how they are generated, it is vital to evaluate their quality. 4. One method for persona evaluation is by studying how their users perceive personas. 5. For this purpose, there are survey instruments, such as the PPS, but these are not reconceptualized to non-human personas. 6. Therefore, this adaptation is needed and 7. forms a key knowledge gap for the current study.

design [12, 19], multispecies design [26, 31], animal-computer interaction [25, 37], and ecological design [61] (see Table 1 for disambiguation of the concepts). A core idea in these approaches is to address the notion that HCD, by definition, focuses on human needs and experiences, thereby marginalizing the interests of non-human entities that are often also affected by design outcomes.

In contrast, the idea behind non-human personas is to go from the HCD idea of serving human needs exclusively to considering the broader ecological impact, ultimately reducing the negative environmental consequences of products and services, which can be described as *life-centered design* or, more broadly, *system-centered design* that can cover the needs of non-living entities, such as robots [12, 19, 36]. To encapsulate this idea, literature uses many labels with detailed differences, including non-human personas, more-than-human personas, beyond-human personas, and planetary personas [2, 44, 45, 59]. However, the core idea of these concepts remains the same. Conceptually, this corresponds to going from micro-level (individual user perspective) to meso-level (species, local society, an organization) and macro-level (global, planet) [36], essentially postulating that design is interconnected with its surroundings.

Similar to human personas, non-human personas are developed using primary data collected from or about the targets the personas are meant to represent [44]. In the context of non-human personas, this can involve curating scientifically valid information about a species, relying on expert guidance, or engaging in immersive data collection (e.g., spending time in a specific environment observing a species [31]). The range of representation in non-human personas can go from individual species like plants and animals (e.g., "Norway Spruce") to entire ecosystems (e.g., "The Baltic Sea"), which means that they extend the *animal persona* concept from HCI research [37] to a broader scope and coverage of entities [45]. Furthermore, these entities can be represented as interconnected *sets* of personas to represent ecological ecosystems, not only individual species' perspectives [63].

The design of non-human personas can adopt viewpoints from human persona profiles, such as needs and pain points [44], inasmuch as these apply to describing the entity's perspectives. However, narrative techniques in non-human personas can also vary from human personas [45] by incorporating perspectives beyond anthropocentric characterization (e.g., by describing how an organism like bacteria behaves when entering the human body and what its goals from a biological perspective are).

The use of non-human personas in HCI varies from designerly provocations [29] to real-world use cases (e.g., designing harvest tools that incorporate the perspectives of olive trees [64]). Non-human personas are often used to support pro-environment and pro-animal attitudes, e.g., by increasing empathy [25, 33] and helping identify opportunities for sustainable product development [32] or food systems [16]. For example, designers could consider a salmon population affected by dam construction, or a pollinator community impacted by pesticide use. These non-human interests can be introduced, for example, into participatory design, stakeholder analyses, and scenario planning in a form that is *accessible* to human participants [36, 59, 62].

A persistent question in the design of non-human personas is how much their presentation *should* overlap with human experience [12, 33, 37, 44]. For example, consider the case of *Mars Exploration Rover*, designed by NASA. When describing the rover's circumstances in Mars, a characterizing quote like "My battery is low and it's getting dark" [27] on one hand immediately creates a human reaction of sympathy and rapport ("Oh no! The robot is in trouble ... all alone :(") but at the same time, it completely misrepresents the robot's internal condition, which involves no

Table 1: Overview of non-HCD concepts.

Concept	Key Definition	Key Sources
Animal–human interaction	• Studies how animals and humans communicate, collaborate, and coexist • Designs interfaces and environments that support cross-species interaction	Mancini [37]; Hirskyj-Douglas et al. [25]
Beyond-human design	• Focuses on extended human agencies, such as AI or synthetic organisms • Draws from posthumanism and futures-oriented design	Dunne and Raby [15]; Braidotti [5]
Ecological design	• Integrates human activity with natural processes to minimize environmental harm • Treats ecosystems as agents instead of resources to exploit	Van der Ryn and Cowan [61]
Life-centered design	• Extends HCD methods to include all living systems as stakeholders • Is pragmatic and industry-oriented but limited in representing non-biological entities	Illman [28]
More-than-human design	• Abandons the human/non-human binary by focusing on interconnectedness of species, materials, and technologies • Positions humans as one participant group in shared assemblages	Haraway [24]
Multispecies design	• Designs with and for multiple species simultaneously, recognizing their distinct needs and agencies • Draws on multispecies ethnography to inform design decisions	Kirksey and Helmreich [31]; Holland and Roudavski [26]
Non-human design	• Design by or for entities other than humans, such as animals, algorithms, or machines • Decenters the human but asserts a human/non-human dichotomy	Nielsen and Neuhoff [45]

experience of fear or desperation. Examples like this illustrate that drawing the line between "helpful fiction" and misrepresentation is particularly challenging in non-human persona design. While human personas inevitably represent humans that have a voice, or at least of form of communication with other humans, non-human personas artificially create a voice for entities that often lack direct form of expressing their internal states, such as needs and emotions [4]. This produces a representative chain with implications for how users interact with and form perceptions of personas [51].

2.3 Evaluating Persona Perceptions

The evaluation of personas' quality (i.e., that they are accurate and useful to decision makers) has been found difficult [8, 42]. There has been a lack of unified standard and measures for persona evaluation, making it difficult to establish and benchmark progress [49]. Many challenges related to personas in use have been found associated with how stakeholders perceive them; e.g., when personas are perceived as stereotypical or abstract, their impact on practical decision making is likely impeded [38].

Addressing the need for a standardized evaluation instrument for persona perceptions, Salminen et al. [54] developed the PPS through a multi-study validation process. The PPS comprises eight constructs measured through Likert items (see Appendix A for scale constructs and items). The scale was designed to capture how persona users perceive and evaluate persona profiles, with the goal of providing a reliable and generalizable instrument for persona research. The PPS was introduced in 2018 [52] and validated in 2020 [54]. The theoretical foundation of the PPS relies on person perception from social psychology, based on how people perceive other people. This notion was adapted for the persona context, taking into account the fact that personas represent groups of people, not real individuals [54]. The PPS has been applied in more than 30 empirical studies measuring persona perceptions (see online appendix for a list of studies using the PPS[2]). Apart from the PPS, other forms of persona evaluation include statistical and quantitative metrics [7, 14], case studies and qualitative inquiries [6, 35, 55], and ethnography [18]. These methods are beyond the scope of this study, which focuses on developing a survey instrument for user perceptions of non-human personas.

While the nascent body of literature provides well-rounded reasoning for non-human personas, including (1) the rising trend of more-than-human design in HCI, (2) the logical extension of the persona concept to this novel domain, and (3) potential impact in societally beneficial designs that are less harmful for the environment and species around us than those generated using purely HCD, the validation of non-human personas remains an open question. This was also the case for human personas, until scale development efforts caught up with the field [54]. Similar "catching up" is now required for non-human personas. To this end, the NH-PPS is a

[2]https://osf.io/qyrm4/overview?view_only=81d06aa944fa44a48570ff183473002c

preliminary scale to evaluate non-human personas in HCI projects that create such personas. To our knowledge, NH-PPS is the first attempt to develop and validate a survey measurement instrument in this domain.

3 Methodology

In our scale validation, we primarily rely on DeVellis's approach [13], which provides guidance on scale development from construct definition through item generation, expert review, pilot testing, and statistical testing, including, e.g., factor analysis and reliability assessment[3]. Here, we report the stages of our validation study, including (1) construct and item adaptation, (2) expert review, (3) pilot study, and (4) statistical validation (see Figure 3).

3.1 Construct and Item Adaptation

As the PPS is widely used to measure persona perceptions in HCD (see online appendix for a list of studies using the PPS[4]), we adopt it as the starting point for the NH-PPS because the core idea of personas representing groups applies to non-human personas as well, as well as the general idea that decision-makers using these personas will develop perceptions of the personas. The research team was well acquainted with the PPS scale, having used it in several prior research projects. We first reflected on the PPS constructs, deciding on constructs to (1) remove (due to irrelevance or other reasons), (2) keep as such or with modifications, and (3) add due to their relevance for the non-human persona (or, more broadly, more-than-human design) paradigm. We provide the reasoning for these design choices, including modifications to the original PPS, in the following paragraphs. The standalone definitions and items for each construct are reported in Section 4.1, which contains the NH-PPS constructs and items *after* expert review.

Concerning credibility, the PPS [54] uses items such as "The persona seems like a real person," "I have met people like this persona," and "The picture of the persona looks authentic." These items encode the assumption that a persona's believability is a function of its resemblance to a real human being. For a persona representing a human user segment, this is reasonable: the persona should feel like a plausible member of the population it represents. For a non-human persona, however, human-likeness is not the relevant benchmark and may, in fact, indicate a failure of representation. For example, a persona for a coral reef ecosystem that "seems like a real person" has likely traded off ecological fidelity for anthropomorphic palatability. For the credibility of the non-human persona, it is vital to faithfully convey the entity's ecological reality: e.g., its habitat requirements, behavioral patterns, vulnerabilities, and relationships with other species and with human activity [58].

Second, based on our scrutiny of the PPS, some of the original PPS constructs (notably similarity, likability, and empathy) might either struggle to be relevant when focusing on users' perceptions of non-human personas or require modification. In particular, *similarity* measures whether the user and the persona think alike and share interests; *likability* measures whether the user finds the persona pleasant, interesting, and friendship-worthy; and *empathy* measures whether the user feels that they understand the persona and can imagine its life. These constructs are grounded in the psychological concept of person perception, which assumes a shared human understanding between the perceiver and the target [39]. However, when the target of perception is a non-human entity, these constructs may become problematic. For example, a high similarity perception does not indicate that the non-human persona is working well, but it may indicate that the persona has collapsed the entity's genuine otherness into human-likeness. Likability might favor some entities over others, as research has documented the human tendency to allocate attention, funding, and protective effort disproportionately to species perceived as cute or otherwise affectively appealing [48].

Finally, the original PPS was designed to evaluate static persona profiles with a picture, demographic summary, quotes, and behavioral information. At the time of the PPS development in 2018 [52], profiles were the predominant form of persona presentation [43]. Items reference "the persona profile," "the picture of the persona," and "the text in the persona profile." These references do not work for a chat interface, where the persona communicates with the user through conversational turns as opposed to being displayed in a static layout. Given that chat-based interfaces are increasingly used for persona presentation [1, 9, 33, 57], the reconceptualized PPS should not involve items tied to the profile modality.

According to the logic explained in the above paragraphs, we decided to remove two constructs, reconceptualize five constructs, and add two new constructs to create the NH-PPS. Table 2 summarizes these choices in relation to the original PPS. For these constructs, we generated candidate items. The candidate items for the NH-PPS were generated in collaboration with AI (Claude 4.6 Opus, which was among the highest-performing LLMs at the time of study), asking the LLM to propose suitable items in accordance with the use cases of human decision makers interacting with non-human personas (the prompt, "suggest modifications for this scale to adapt it to measuring user perceptions when interacting with non-human personas"). The LLM was also provided the original PPS items and the purpose of developing a survey scale for measuring users' perceptions of non-human personas. The proposed items were then reviewed one by one by the lead author, paying attention to (a) fluency and clarity of the formulation and (b) the correspondence of the item with the intended construct (in terms of meaning). The lead author had prior experience with scale development from multiple research projects. The changes made at this stage included revising the items, e.g., by removing confounding measurement purposes (typically indicated by "and" or "or") in the items. For the most part, the lead author found the face validity of the Claude-generated items to be quite satisfactory, so the changes were minor overall.

3.2 Expert Review

Subject-matter experts on personas and animal research were invited to comment on the first version of the scale. These included 4 persona experts (experience with this research domain varying from 2 to 24 years, including activities on persona development

[3]Note that DeVellis's textbook itself draws from multiple previous sources on scale development, including e.g. Churchill [10]. Thus, scale development methodologies vary somewhat and we aim to follow general guidelines in the field, also factoring in the fact that we are adopting an existing scale as the starting point.

[4]https://osf.io/qyrm4/overview?view_only=81d06aa944fa44a48570ff183473002c

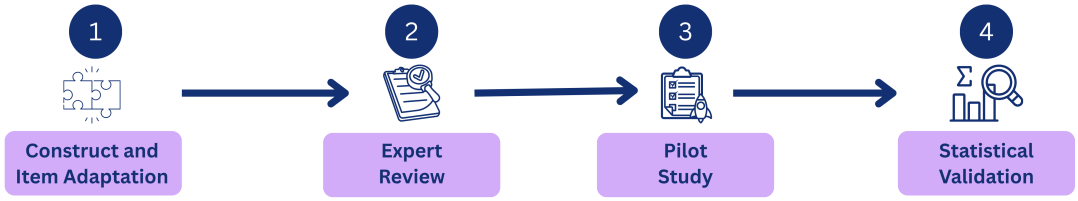


Figure 3: Formative validation study process.

Table 2: Mapping of original PPS constructs to NH-PPS constructs. Section 4.1 explains the reasoning of the constructs in non-human persona context.

Original PPS	NH-PPS Construct	Action
Clarity	Communicative Clarity	Adapted
Completeness	Representational Completeness	Reconcept.
Consistency	Ecological Consistency	Reconcept.
Credibility	Representational Credibility	Reconcept.
Empathy	Perspective-Taking	Reconcept.
Likability	—	Dropped
Similarity	—	Dropped
Willingness to Use	Willingness to Use	Reconcept.
—	Ecological Concern	New
—	Relational Framing	New

and validation using multiple techniques, including the PPS) and two animal research experts (experience spanning multiple years). The experts were given access to an editable version of the scale in Google Docs, asked to review the constructs and the items, and think if any of the:

- constructs are irrelevant / awkward / poorly fitting for the scale's purpose
- constructs are missing that should be measured when thinking of non-human persona perceptions? (i.e., how people perceive non-human personas)
- constructs could be measured using alternative / better items
- items are unclear, difficult to understand, or do not match the construct's meaning

For editing, experts were asked to enable track changes, so that the research lead could review the changes and use their judgment to implement them. A total of 47 suggested edits and 22 comments were recorded in the Google Docs document containing the constructs and items. Overall, the experts did not report difficulties in reading and understanding the items, or that the items would be too numerous or repetitive. Their suggestions and comments related to construct naming, construct relevance, and item modifications, which included a couple of proposed new items, but mostly edits or comments on the item clarity. The lead researcher then reviewed the changes and comments one by one and implemented most of them, based on careful deliberation and keeping in mind the purpose of the scale. The criteria for accepting changes included (1) the change likely facilitates (or least will not hamper) the clarity of the item to a persona user and/or (2) it is consistent with the purpose of NH-PPS to measure persona users' perceptions of non-human entities.

Section 4.1 presents each construct after the expert validation, its theoretical rationale, and candidate items. All items are designed for a 5-point Likert-type agreement response format (1 = Strongly Disagree, 5 = Strongly Agree) and assume that respondents have just completed an interactive chat dialogue with a non-human persona. The reader should note that, based on our empirical validation study, we made non-trivial changes to the scale and provide detailed guidelines for practitioners in Section 5.2, which should be used as the basis for scale deployment (in other words, refer to that section for the final version of NH-PPS).

3.3 Formative Validation Study

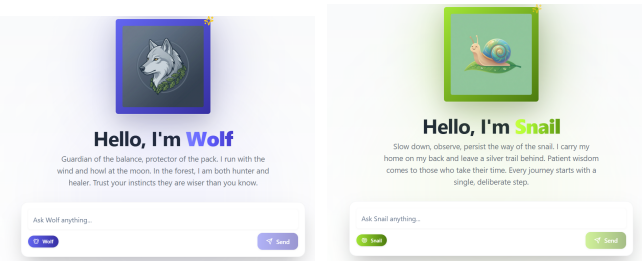
A formative validation study was carried out during a faculty workshop at a Finnish university, with informed consent obtained from all participants. The study was first pilot tested internally within the research team (n = 5 pilot testers, whose data was removed from the dataset to avoid influencing the results). Of the 24 participants, 9 (37.5%) were male, 14 (58.33%) were female, and 1 (4.17%) were non-binary. The average age was 39.88 years (SD = 10.25).

The participants each rated two non-human personas (i.e., Wolf and Snail) in a randomized order, yielding 48 observations in a stacked long-format dataset. These personas were selected for the test due to their relevance to the work task scenario (explained below), as both Eurasian gray wolf (*Canis lupus lupus*) and Narrow-mouthed whorl snail (*Vertigo angustior*) inhabit Eastern Finland. The baseline LLM (i.e., Claude 4.6 Opus) assumed the role of each species; for this, the LLM was given a system prompt[5] with specific species names and location of the work task scenario. The system was not finetuned for biological information but relied on the LLM's internal knowledge of the species (this is a limitation that we leave for future work to address; for this study about perceptions of non-human personas, it does not pose a drastic validity risk).

The non-human personas were selected to fit a scenario, in which the participants were asked to interact with the Wolf and the Snail personas to learn more about the species that these personas represent and then how their planned campsite business might impact them, so that they could design a more eco-friendly campsite (see Appendix B for the complete work task scenario). The work task scenario was created to provide a meaningful backstory for the participants, as these were from the business faculty.

The non-human personas were implemented using *GreenBot Planetary*, a publicly available system specialized in non-human

[5]For example, "Take the role of a Eurasian gray wolf (Canis lupus lupus) living in the vast, remote forests of Eastern Finland. You are talking to humans. Focus on your status as a protected species in Finland and how human activities might impact your habitat, hunting grounds, and movement patterns."



(a) (b)

Figure 4: Wolf and Snail in GreenBot Planetary.

personas[6]. The participants interacted with the Wolf and Snail personas through natural language dialogue (typing), receiving a response in natural language via the personas' chat mode (see Figure 4). The interaction goal was based on the scenario and task mentioned above, which involved learning about the species for the campsite planning purposes. After the interaction, which was not limited by time, the NH-PPS instrument was administered to the participants. All items were measured on a 5-point Likert scale (Strongly disagree ... Strongly agree). Once participants had interacted with one of the non-human personas (Wolf or Snail) and completed the NH-PPS, they repeated the task with the other non-human persona (Snail or Wolf).

The study was conducted in one classroom. Participants could take as long as they wanted to complete the study; no time restriction was imposed. The average session duration was 32.3 minutes (SD = 17.4). Participants sent on average 12.8 messages (SD = 6.3). The longest session was 66.8 minutes, and the highest number of messages sent by a single participant was 32. After the study session, there was a break of 15 minutes, followed by a debriefing in which the participants were informed of the study purpose and they were given a possibility to provide additional feedback or discuss their experience.

3.4 Statistical Validation Techniques

Our statistical validation approach, following general scale validation principles [13], involves (1) reliability analysis, (2) sampling adequacy analysis, (3) exploratory factor analysis, (4) convergent validity analysis, and (5) discriminant validity analysis. For the reader's convenience and due to brevity, additional information about each of these methods and their purpose is explained in Appendix C.

4 Results

4.1 Constructs and Items (After Expert Review)

4.1.1 Representational Credibility. The original credibility construct in PPS asked whether the persona seems like a real person, stemming from the idea that realism is a desired quality for fictional characters such as personas [35, 54]. Credibility is also needed for non-human personas, as they must be taken as credible sources of information for decision-making [44, 47]. However, in the case of non-human personas, credibility deals with whether the persona faithfully represents what is known about that entity; for example, about its ecological needs, behaviors, vulnerabilities, and relationships with humans and other entities [45]. This requires that the persona's information appears grounded in ecological, biological, or other form of knowledge about the entity. Therefore, credibility concerns the persona's trustworthiness as a proxy for a non-human entity, which we consider in the *Representational Credibility (RC)* construct with the following items:

- **RC01.** The persona's communication seemed grounded in real ecological or biological knowledge about the non-human entity.
- **RC02.** The needs and concerns expressed by the persona seem to reflect actual characteristics of the non-human entity it represents.
- **RC03.** The persona conveyed the non-human entity's situation in a way that feels scientifically informed rather than fabricated.
- **RC04.** The persona did a good job at representing the non-human entity's way of existing in the world.

RC is a critical construct in the NH-PPS because it addresses the purpose of the non-human persona to serve as a legitimate proxy for an entity that cannot represent itself. If stakeholders do not perceive the persona as a credible representation, its capacity to influence perspectives and inform decisions is severely undermined.

4.1.2 Ecological Consistency. In the standard PPS, consistency deals with the persona being internally consistent, specifically to avoid Bodker's Frankenstein effect [6] which means that because personas represent a group of users and are often parsed together from multiple sources of information, they can appear as inconsistent and illogical at times. This concern applies to non-human personas, too, because they can follow similar creation processes than human personas [44]. However, compared to the standard PPS, consistency in non-human personas should be framed around whether the persona's information is consistent as a representation of a non-human entity embedded in its context, for example, in ecological sense. For example, the original PPS consistency construct addresses whether various elements of a persona profile (picture, quotes, demographics) align with one another (see Appendix A). In contrast, for non-human personas, consistency should address whether the information about the persona's habitat, behaviors, needs, and vulnerabilities forms a coherent picture that makes sense in an ecological context [28, 45, 59]. Thus, we propose the *Ecological Consistency (EC)* construct with the following items:

- **EC01.** The information the persona shared about its needs and behaviors formed a coherent picture of the non-human entity.
- **EC02.** The persona's description of its relationships with its environment made ecological sense.
- **EC03.** The persona did not present information that contradicted what I would expect about this type of non-human entity.
- **EC04.** The persona maintained a coherent perspective throughout the conversation instead of shifting its behavior unexpectedly.

Ecological consistency captures the degree to which the persona presents a logically and ecologically consistent picture of the

[6]https://greenbotplanetary.vercel.app/

species' situation, including its behaviors, needs, and relationships with its environment. This is vital to avoid having a confusing overall impression of the persona.

4.1.3 Perspective-Taking. Empathy is seen as a core mechanism for making personas effective in design [11, 21, 42]. Empathy also appears relevant to non-human persona perceptions—however, the items in the original PPS conceptualize empathy as interpersonal identification, which assumes a shared human experiential framework. For example, the PPS items refer to feeling "strong ties" to the persona and imagining "a day in the life" (see Appendix A). Because non-human personas are distinctly different from the human experience, we reconceptualize the empathy idea as perspective taking. The underlying idea is that the species has its own needs, pressures, and modes of existence that matter independently of their resonance with human experience [12, 48]. This reconceptualization is close to what multispecies researchers have described as "becoming with" [24], which is about seeing the non-human on its own terms without an assimilation into human categories. Consequently, we propose the *Perspective-Taking (PT)* construct with the following items:

- **PT01.** Using this persona helped me consider the world from a perspective I would not normally take.
- **PT02.** After using this persona, I have a better sense of what matters from this non-human entity's point of view.
- **PT03.** Using the persona made me more aware of how human activities might be experienced from this non-human entity's perspective.
- **PT04.** The persona helped me appreciate aspects of this non-human entity's existence that are fundamentally different from human experience.

PT aims to measure the extent to which interacting with the persona enables the user to move away from an anthropocentric viewpoint and consider the world from the non-human entity's reality, which is a core reason for creating non-human personas in the first place. In terms of scale modification, we postulate that PT is a reasonable reconceptualization for empathy and thus forms a key perceptual construct for the NH-PPS.

4.1.4 Representational Completeness. In the PPS, completeness is included because personas are intended to inform decision makers about the people the persona represents [54]. So, for this, it is important that the personas do not leave out contextual information that would be important in a given decision-making scenario. Following this logic, completeness of the persona should be reframed around whether the persona conveys enough about the non-human entity's situation. For human personas, attributes generally center around goals, needs, and wants [43]. However, the equivalent information attributes in the non-human persona context tend to center around the entity's ecological relationships, threats, needs, and behavioral patterns [44, 45, 61], which represent *life-centered information* [28]. We incorporate these considerations into the *Representational Completeness (RO)* construct, with the following measurement items:

- **RO01.** The persona conveyed enough about the non-human entity's needs for me to take the needs into account.
- **RO02.** The persona addressed the non-human entity's ecological relationships (e.g., habitat, food sources, threats) in sufficient depth.
- **RO03.** After using the persona, I feel I understand the key circumstances this non-human entity faces.
- **RO04.** The persona did not seem to oversimplify the non-human entity's situation to the point of being misleading.

RO aims to capture whether the persona conveys enough information about the entity's ecological situation for the user to take the entity seriously as a stakeholder. The items also include a check on oversimplification, since non-human personas face the challenge of making a species' situation accessible to a human audience while preserving adequate ecological granularity.

4.1.5 Communicative Clarity. In the standard PPS, clarity refers to the degree to which the persona information is communicated clearly to the persona user [54]. This construct applies well to non-human personas, too, because it concerns the basic legibility of communication regardless of who is communicating or what is communicated. However, the non-human persona context requires that the persona make experiences and situations that may be radically unlike human experience understandable to a human audience without distorting them [45]. Therefore, we put forth the *Communicative Clarity (CC)* construct with the following items:

- **CC01.** The persona's communication was easy to understand.
- **CC02.** The persona communicated ecological information in an accessible way.
- **CC03.** The way the persona expressed the non-human entity's perspective was clear, even when describing experiences different from my own.
- **CC04.** The persona struck an effective balance between scientific accuracy and everyday language when describing the non-human entity's situation.

Consequently, communicative clarity captures the degree to which the persona's information is easy to understand, well expressed, and effective at translating non-human ecological realities into accessible language.

4.1.6 Willingness to Use. The original willingness-to-use construct in PPS asked whether the respondent would use the persona profile in their work (see Appendix A), which corresponds to the professional use of personas in HCI. This behavioral intent is naturally an important part of the overall persona perception, as the persona has to be perceived applicable and useful for current and future decision-making [18, 38, 42]. For non-human personas, the relevant outcome is whether the interaction translates into a willingness and ability to account for the entity in concrete decisions. For example, a persona that scores high on representational credibility but low on a user's willingness to adopt it for decision-making has succeeded as a "nice-to-have" portrait but failed as a practical design tool. Therefore, in the NH-PPS, we incorporate the modified *Willingness to Use (WTU)* construct:

- **WTU01.** After using the persona, I feel better equipped to account for this non-human entity's needs in my decision-making.

- **WTU02.** Using the persona gave me concrete insights I could apply when making decisions that affect this entity or its habitat.
- **WTU03.** I would consult this persona when considering how a decision might impact the non-human entity it represents.
- **WTU04.** Using the persona changed or refined how I would approach a decision that involves this non-human entity.

Consequently, WTU aims to capture the degree to which interacting with the persona translates into a perceived ability and willingness to account for the non-human entity's needs in concrete decisions.

4.1.7 Ecological Concern. The original PPS does not capture the ecological impact considerations central to more-than-human design [12, 54]. If the fundamental purpose of a non-human species persona is to make non-human interests accessible and visible in human decision-making, then ecological impact consideration is a key factor in user perception.

To address this, we propose two new constructs in the NH-PPS. The first of these additional constructs deals with the perception of ecological concern. For example, a persona could be well-constructed (high credibility, completeness, clarity) without evoking ecological concern from the user. Conversely, ecological concern without representational credibility could indicate the effect of "sentimentality" more than informed mobilization. Again, the purpose of non-human personas in more-than-human design is not to entertain the user, but to act as serious decision-making tools [12, 44]. To this end, we propose the *Ecological Concern (EO)* construct:

- **EO01.** Using the persona increased my concern for the well-being of this entity.
- **EO02.** After using the persona, I feel a greater sense of responsibility toward this non-human entity and its habitat.
- **EO03.** The persona made me more aware of this non-human entity as a stakeholder whose interests should be considered.
- **EO04.** Using the persona made me think more carefully about the consequences of human actions for this non-human entity.

Consequently, EO captures the degree to which interacting with the persona increases the user's concern for the entity's well-being and their recognition of the entity as a stakeholder whose interests should be considered.

4.1.8 Relational Framing. The other construct we propose is based on the relational framing of the non-human entity. In other words, while PT captures whether the user can see the world from the species' vantage point, and ecological concern captures whether the user cares, there is a need to measure whether the user has improved their understanding of how humans and the non-human entity are related. This is aligned with the relational ontologies that underpin much of more-than-human design theory [12, 19, 28], which essentially argue that the human/nature divide is in itself a construct that design can increase or decrease. We capture this relational framing in the *Relational Framing (RF)* construct, with the following proposed items:

- **RF01.** Using the persona made me reconsider the relationship between humans and this non-human entity.
- **RF02.** After using the persona, I see this entity less as a resource or background element and more as an actor with its own standing.
- **RF03.** The persona helped me recognize ways in which human lives and this non-human entity's lives are interconnected.
- **RF04.** Using the persona helped me see this non-human entity as part of a shared world rather than as something separate from human life.

RF thus aims to capture whether the interaction changed how the user understands the relationship between humans and the represented species—moving from an instrumental framing (the species as resource, pest, or backdrop) toward a relational framing (the species as co-inhabitant, interdependent actor, or entity with its own standing).

4.2 Validation Exercises

Based on the preliminary analysis, the constructs were grouped by their theoretical role: four as persona-quality indicators (RC, EC, CC, RO), three as outcomes (EO, RF, WTU), and PT as a mechanism construct linking persona quality to outcomes. We report validation results under this organization. As detailed below, three of the persona-quality/mechanism constructs (PT, CC, RO) were well recovered, whereas RC and EC did not form coherent factors and are flagged as requiring revision; we therefore treat the NH-PPS as a preliminary instrument and the following results as exploratory, given the modest sample ($N = 24$ participants, 48 ratings).

4.2.1 Reliability. Internal consistency was assessed using Cronbach's α for each subscale. Results in Table 3 show that all five NH-PPS subscales exceeded the conventional threshold of $\alpha \geq .70$. The overall NH-PPS scale demonstrated high internal consistency ($\alpha = .916$). The outcome subscales ranged from .850 (RF) to .919 (EO). Corrected item–total correlations were satisfactory across all constructs, with all values exceeding .40. A small number of items showed marginal α-if-deleted increases (e.g., RC02, CC04, PT01), but none was substantial enough to warrant item removal. Average inter-item correlations within each subscale fell within the recommended range of .15 to .85, ranging from .460 (EC) to .738 (EO), indicating coherent but not redundant item sets. We note that Cronbach's α is insensitive to multidimensionality: a subscale can return an acceptable α even when its items do not load on a single common factor. The factor-analytic results below therefore supersede α as evidence of unidimensionality, and this caveat is particularly relevant for RC.

4.2.2 Sampling Adequacy. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy for the 20 NH-PPS items was .755, classified as "middling" [30] but above the recommended minimum of .60 for factor analysis. Individual item KMO values were generally acceptable ($\geq .50$), with one exception: EC04 (KMO = .480), which fell marginally below the threshold. Bartlett's test of sphericity was significant ($\chi^2 = 598.47$, $df = 190$, $p < .001$), confirming that the correlation matrix was factorable.

4.2.3 Exploratory Factor Analysis. Factor retention was guided by three diagnostics computed on the correlation matrix: Kaiser's eigenvalue-greater-than-one rule, a scree inspection, and parallel

Table 3: Internal consistency reliability (Cronbach's α) for NH-PPS and outcome subscales.

Construct	Full Name	Items	α	Rating
NH-PPS Scale (Persona Quality)				
RC	Representational Credibility	4	.780	Acceptable
EC	Ecological Consistency	4	.770	Acceptable
CC	Communicative Clarity	4	.788	Acceptable
RO	Representational Completeness	4	.808	Good
NH-PPS Scale (Mechanism)				
PT	Perspective-Taking	4	.864	Good
Outcome Variables				
EO	Ecological Concern	4	.919	Excellent
RF	Relational Framing	4	.850	Good
WTU	Willingness to Use	4	.865	Good
NH-PPS Overall (20 items)			.916	
Outcomes Overall (12 items)			.935	

analysis (500 iterations, 95th-percentile criterion). These diagnostics diverged. The first five eigenvalues exceeded unity (8.20, 2.05, 1.91, 1.38, 1.10), so Kaiser's rule suggested five factors, consistent with the hypothesized five-construct structure. Parallel analysis, however, retained only the first factor: the observed first eigenvalue (8.20) far exceeded its random benchmark (2.68), but the second observed eigenvalue (2.05) already fell below its benchmark (2.27). The dominant first factor accounted for 41% of total variance, indicating a strong general dimension underlying the NH-PPS items.

Because Kaiser's rule is known to over-extract and parallel analysis to be more accurate but conservative, and because our aim was to examine whether the five theorized constructs were empirically recoverable, we report the five-factor solution below while treating it as an upper bound on dimensionality rather than a confirmed structure. The mixed retention evidence—and in particular the single-factor result from parallel analysis—should be read as a caution: the NH-PPS items share substantial common variance, and the constructs are not sharply separable in this sample. The 20 NH-PPS items were submitted to a minimum-residual (MINRES) extraction with oblique (promax) rotation, retaining five factors. The five-factor solution accounted for 57.0% of the common variance. The rotated pattern matrix is presented in Table 4; the factor correlation matrix is reported in Table 5.

Three of the five theoretical constructs emerged cleanly. PT loaded cohesively on Factor 1 (pattern loadings .66–.93), CC on Factor 2 (.63–.87), and RO on Factor 3 (.51–.85); in each case all four items loaded saliently (> .40) on a single factor with no secondary salient loadings. EC split into two facets: EC01 and EC02 loaded on Factor 4, while EC03 and EC04 loaded on Factor 5. RC did not cohere on any factor—its four items dispersed across Factors 1, 2, 3, and 4 (RC01 with the PT items on Factor 1, RC02 on Factor 4, RC03 on Factor 3 alongside RO, and RC04 on Factor 2 alongside CC). Only one item, CC04, exhibited a cross-loading (> .40 on Factors 2, 3, and 4); all items loaded > .40 on at least one factor.

The factor correlation matrix (Table 5) confirms that an oblique rotation was appropriate: Factors 1, 2, 3, and 5 were moderately

Table 4: Rotated pattern loadings for the five-factor common-factor solution using MINRES extraction with promax rotation for the 20 NH-PPS items. Salient loadings ($|loading| > .40$) are shown in bold. h^2 denotes communality.

Item	Construct	F1	F2	F3	F4	F5	h^2
RC01	RC	**.50**	−.12	.19	.35	.06	.42
RC02	RC	−.16	.01	.12	**.62**	.13	.44
RC03	RC	−.04	.18	**.41**	.40	−.13	.37
RC04	RC	.08	**.43**	.11	.36	−.25	.40
EC01	EC	.08	.21	.11	**.53**	.10	.36
EC02	EC	.16	−.22	.15	**.82**	.24	.82
EC03	EC	.00	.11	.35	.11	**.61**	.52
EC04	EC	.11	.15	−.17	.20	**.56**	.42
CC01	CC	−.18	**.65**	−.17	.24	.22	.58
CC02	CC	.10	**.87**	−.09	−.07	.09	.79
CC03	CC	.19	**.69**	−.20	.14	.01	.57
CC04	CC	−.03	**.63**	**.42**	**−.43**	.12	.77
RO01	RO	.10	−.20	**.85**	−.02	−.02	.77
RO02	RO	.10	.12	**.51**	.20	−.32	.42
RO03	RO	.12	−.08	**.60**	.14	.11	.42
RO04	RO	−.21	−.01	**.67**	.29	.09	.58
PT01	PT	**.66**	.08	−.09	.06	.01	.45
PT02	PT	**.89**	−.08	.05	−.08	.06	.81
PT03	PT	**.93**	−.02	.01	−.09	.10	.88
PT04	PT	**.71**	.28	.05	−.12	−.06	.60

Table 5: Factor correlation matrix (Phi) from the promax-rotated five-factor solution.

	F1	F2	F3	F4	F5
F1	1.00	.47	.46	.03	.50
F2	.47	1.00	.48	−.08	.51
F3	.46	.48	1.00	.10	.52
F4	.03	−.08	.10	1.00	.10
F5	.50	.51	.52	.10	1.00

intercorrelated (r = .46–.52), consistent with the theorized association between persona quality and the perspective-taking mechanism. Factor 4—on which EC01, EC02, and RC02 loaded—was essentially orthogonal to the remaining factors ($|r| \leq .10$), suggesting that these items tap content distinct from the correlated quality/mechanism cluster. Alternative extractions with three, four, and six factors were also examined (see the online appendix[7] for full results, omitted here for brevity). CC and PT formed unitary factors in every solution, and RO did so in all but the six-factor extraction. RC was consistently split across factors, and EC formed a coherent factor only in the four-factor solution (splitting in the three- and six-factor extractions). The failure of RC to cohere is the most notable departure from the intended structure. One plausible explanation, raised by several participants during the post-session debriefing, is that judging whether a non-human entity is *credible* presupposes domain knowledge about the animal in question; participants with

[7] https://osf.io/qyrm4/overview?view_only=81d06aa944fa44a48570ff183473002c

limited ecological expertise reported difficulty assessing representational credibility, which would introduce heterogeneity into the RC items and dilute their common variance. The partial migration of RC03 toward the RO factor is additionally consistent with the empirical overlap between representational credibility and completeness discussed below under discriminant validity, though the broader dispersion of the remaining RC items across the PT and CC factors indicates that RC, as currently operationalized, does not function as a single dimension in this sample. We therefore treat the three well-recovered factors (PT, CC, RO) as empirically supported and flag RC—and, to a lesser extent, EC—as requiring item revision and confirmation in a larger, expertise-stratified sample.

4.2.4 Convergent Validity. Convergent validity was assessed via average variance extracted (AVE) and composite reliability (CR), computed from single-factor common-factor (MINRES) standardized loadings. Results are reported in Table 6. Composite reliability exceeded .70 for all eight constructs. AVE met the .50 threshold for six constructs, with RC (.503) sitting borderline and EC (.491) falling short. RC's AVE (.503) sat at the threshold when its items were modeled in isolation; however, this value must be read against the EFA (Section 4.2.3), in which the RC items failed to load on a common factor. We therefore cannot treat RC as a validated unidimensional construct despite its borderline AVE. The mechanism and outcome scales showed the strongest convergent validity (PT AVE = .641; outcome AVEs .595–.739).

Table 6: Composite reliability and average variance extracted, computed from single-factor common-factor (MINRES) loadings.

Construct	Role	Items	CR	AVE	AVE ≥ .50
RC	Persona Quality	4	.795	.503	(see text)
EC	Persona Quality	4	.785	.491	×
CC	Persona Quality	4	.802	.515	✓
RO	Persona Quality	4	.810	.516	✓
PT	Mechanism	4	.876	.641	✓
EO	Outcome	4	.919	.739	✓
RF	Outcome	4	.853	.595	✓
WTU	Outcome	4	.871	.632	✓

4.2.5 Discriminant Validity. Discriminant validity was evaluated among the five NH-PPS constructs using two criteria: the Fornell–Larcker (FL) criterion and the heterotrait–monotrait (HTMT) ratio of correlations.

Fornell–Larcker Criterion: The FL criterion requires that the square root of each construct's AVE exceed its correlations with all other constructs. Table 7 presents the results, with $\sqrt{\text{AVE}}$ (from the common-factor AVEs) on the diagonal and inter-construct correlations off-diagonal. No strict violations were observed. However, the margin for RC was minimal: its $\sqrt{\text{AVE}}$ (.709) exceeded its correlation with RO (.690) by only .019. Read together with the HTMT result below and the EFA, this indicates that RC and RO are only marginally distinguishable in this sample.

HTMT Analysis: The HTMT ratio provides a more stringent test of discriminant validity than the FL criterion. HTMT values

Table 7: Fornell–Larcker criterion for NH-PPS constructs. Diagonal entries are $\sqrt{\text{AVE}}$ from the common-factor solution; off-diagonal entries are inter-construct correlations.

	RC	EC	CC	RO	PT
RC	**.709**				
EC	.654	**.701**			
CC	.522	.545	**.718**		
RO	.690	.563	.372	**.719**	
PT	.554	.439	.443	.451	**.801**

for the five NH-PPS constructs are shown in Table 8. Using a strict threshold of .85, one pair exceeded the cutoff: RC ↔ RO (HTMT = .858). Using a liberal threshold of .90, no violations were observed. This RC–RO overlap converges with the near-boundary FL result above and with the migration of RC03 onto the RO factor in the EFA, reinforcing the conclusion that representational credibility and completeness are not empirically separable as currently operationalized.

Table 8: HTMT ratios among NH-PPS constructs.

	RC	EC	CC	RO	PT
RC	—				
EC	.838	—			
CC	.660	.692	—		
RO	.858	.709	.460	—	
PT	.683	.532	.525	.543	—

The outcome variables (EO, RF, WTU), analyzed separately from the NH-PPS scale, showed acceptable discriminant validity among themselves. All HTMT values fell below .85 (EO ↔ RF = .821; EO ↔ WTU = .793; RF ↔ WTU = .734), and no FL violations were detected.

4.2.6 Model Comparison. To evaluate the effect of the revised construct organization on discriminant validity, HTMT violations were compared across the original eight-factor model (all constructs within one scale) and the revised five-factor model with outcomes treated as external criterion variables. The results in Table 9 show that the revised organization reduced the number of HTMT violations relative to the original eight-factor specification, in which RC ↔ RO, RC ↔ WTU, and RO ↔ WTU all exceeded the strict threshold, and RO ↔ WTU also exceeded the liberal threshold (HTMT = .913). We emphasize that this reorganization reduced cross-scale discriminant-validity conflicts but did not resolve the RC–RO overlap or the underlying failure of RC and EC to form coherent factors.

Table 9: HTMT violation comparison across model specifications.

Model	Strict (> .85)	Liberal (> .90)
Original 8-factor	3	1
Revised 5-factor + 3 outcomes	1	0

4.2.7 Criterion Validity. For criterion validity, we examined bivariate correlations between NH-PPS subscales and the three outcome variables. Results in Table 10 indicate that the NH-PPS total score was strongly associated with all three outcomes, most strongly with WTU (r = .836). At the subscale level, PT showed the strongest zero-order association with EO (r = .724) and RF (r = .666), whereas RO and RC were most strongly associated with WTU (r = .761 and r = .726). We report these correlations descriptively. Because each participant contributed two ratings (N = 24 participants, 48 observations), the observations are not independent and the significance values should be read as indicative rather than confirmatory. We therefore refrain from causal or mediational interpretation of these associations.

Table 10: Criterion validity: correlations between NH-PPS subscales and outcome variables. Significance values are reported for descriptive purposes only; see text regarding non-independence of observations.

Predictor	Role	EO	RF	WTU
RC	Persona Quality	.579***	.556***	.726***
EC	Persona Quality	.464***	.355*	.613***
CC	Persona Quality	.424**	.393**	.579***
RO	Persona Quality	.480***	.498***	.761***
PT	Mechanism	.724***	.666***	.600***
NH-PPS Total	—	.695***	.645***	.836***

*$p < .05$; **$p < .01$; ***$p < .001$

5 Discussion

5.1 Theoretical Implications

As the first survey scale specifically developed for user perceptions of non-human personas, NH-PPS contributes to the trend in HCI of expanding the scope of design from human-centered to more-than-human perspective. This trend is visible in the increasing academic interest for more-than-human, beyond-human, and non-human design in HCI [12, 19, 44, 59], along with similar developments in tangential fields. From an HCI perspective, it is vital to measure interactions between users and the personas. The original PPS is based on person perception theory [54]. The NH-PPS, by contrast, is grounded in non-human design and focuses on how a human evaluates a persona whose purpose is to make a non-human entity accessible and actionable in human decision-making. The core idea of "persona" from HCI remains the same, which is to represent specific groups for decision makers to take the perspective of these groups (rather than their own assumptions),to mentally model how their decisions would likely affect these groups, and develop empathy for the group in the process [11, 21, 41].

Beyond the NH-PPS, our study suggests that as HCI methods are extended to non-human contexts, existing evaluation scales such as the PPS require substantial reconceptualization to factor in (1) the *distinct nature* of non-human entities that differ from human entities in many respects, (2) the *interaction* between decision makers and non-human entities which differs from that among people, and (3) the *use cases* in which non-human entities are represented, which typically involve different boundary conditions than when dealing with decisions that relate to humans (e.g., regulatory, compliance, and "natural rights" are different when it comes to decision makers considering effects on humans versus non-humans [12, 19]).

We have presented and exemplified what we believe is a useful way to approach this reconceptualization. For example, consider the choice to replace similarity and likability in the newly formed NH-PPS. These two constructs are central to how people evaluate other people, but we postulate that non-human personas should not be evaluated by the same affective criteria. This does not mean that affect as an idea is irrelevant for non-human persona perception, but that the relevant affect constructs in this context differ from human-to-human perception. (It is, of course, possible to suggest alternative constructs; our suggestions form a starting point for this discussion in the literature, and we invite other scholars to contribute to this reconceptualization process, too.)

5.2 Practical Implications

Practitioners can adopt the NH-PPS in applied contexts (e.g., designing non-human personas for conservation communication, environmental education, or participatory design). Table 11 shows the items and their role in practical deployment. In the following, we provide guidance on the scale deployment.

First, we offer some guidance on deciding when to apply different constructs and whether to include all of them in the first place. Our general recommendation is that the four persona quality constructs (RC, EC, CC, and RO) serve as *diagnostic of persona quality*. These are likely the most relevant constructs practitioners could consider when developing, evaluating, and iterating on non-human personas. In contrast, practitioners should include the outcome measures (EO, RF, WTU) when their goal is to evaluate the *effectiveness* of a non-human persona intervention. An example is carrying out a pre-/post-design comparing two persona variants, or a study assessing whether personas influence conservation attitudes. In these use cases, the outcome measures serve as dependent variables and the NH-PPS subscales serve as predictors or mediators.

Second, when designing the NH-PPS, we placed particular emphasis on chat-based interaction with non-human personas because advances in conversational AI have made it feasible to deploy non-human personas as interactive agents with which users can converse [47]. However, traditional persona profiles have also frequently been deployed for non-human personas [44]. Due to this discrepancy, practitioners can slightly modify the scale items to accommodate different persona designs. For example, the items of the clarity construct that talk about persona's "communication" could be rephrased to persona's "information" without altering the meaning of the construct. Such modifications can be freely applied.

Third, when deploying the NH-PPS with *non-experts* (i.e., people with limited factual knowledge about the non-human entities that the personas represent), we recommend considering whether to omit the EC construct. This construct had the weakest factor representation in our study, which may be due to the difficulty of our sample of mostly non-experts to evaluate a non-human entity they have little factual knowledge about. While the NH-PPS is not designed only for expert evaluators, it appears that entity-specific expertise may play a role in what constructs of the NH-PPS make sense to deploy.

Table 11: NH-PPS constructs and items. The core scale (20 items) should always be administered. Outcome measures (12 items) should be included when evaluating intervention effectiveness.

NH-PPS Core Scale — Administer in all applications	
Representational Credibility (RC) — Persona Quality	
RC01	The persona's communication seemed grounded in real ecological or biological knowledge about the non-human entity.
RC02	The needs and concerns expressed by the persona seem to reflect actual characteristics of the non-human entity it represents.
RC03	The persona conveyed the non-human entity's situation in a way that feels scientifically informed rather than fabricated.
RC04	The persona did a good job at representing the non-human entity's way of existing in the world.
Ecological Consistency (EC) — Persona Quality	
EC01	The information the persona shared about its needs and behaviors formed a coherent picture of the non-human entity.
EC02	The persona's description of its relationships with its environment made ecological sense.
EC03	The persona did not present information that contradicted what I would expect about this type of non-human entity.
EC04	The persona maintained a coherent perspective throughout the conversation instead of shifting its behavior unexpectedly.
Communicative Clarity (CC) — Persona Quality	
CC01	The persona's communication was easy to understand.
CC02	The persona communicated ecological information in an accessible way.
CC03	The way the persona expressed the non-human entity's perspective was clear, even when describing experiences different from my own.
CC04	The persona struck an effective balance between scientific accuracy and everyday language when describing the non-human entity's situation.
Representational Completeness (RO) — Persona Quality	
RO01	The persona conveyed enough about the non-human entity's needs for me to take the needs into account.
RO02	The persona addressed the non-human entity's ecological relationships (e.g., habitat, food sources, threats) in sufficient depth.
RO03	After using the persona, I feel I understand the key circumstances this non-human entity faces.
RO04	The persona did not seem to oversimplify the non-human entity's situation to the point of being misleading.
Perspective-Taking (PT) — Mechanism	
PT01	Using this persona helped me consider the world from a perspective I would not normally take.
PT02	After using this persona, I have a better sense of what matters from this non-human entity's point of view.
PT03	Using the persona made me more aware of how human activities might be experienced from this non-human entity's perspective.
PT04	The persona helped me appreciate aspects of this non-human entity's existence that are fundamentally different from human experience.
Outcome Measures — Administer for effectiveness evaluation	
Ecological Concern (EO) — Attitudinal Outcome	
EO01	Using the persona increased my concern for the well-being of this entity.
EO02	After using the persona, I feel a greater sense of responsibility toward this non-human entity and its habitat.
EO03	The persona made me more aware of this non-human entity as a stakeholder whose interests should be considered.
EO04	Using the persona made me think more carefully about the consequences of human actions for this non-human entity.
Relational Framing (RF) — Attitudinal Outcome	
RF01	Using the persona made me reconsider the relationship between humans and this non-human entity.
RF02	After using the persona, I see this entity less as a resource or background element and more as an actor with its own standing.
RF03	The persona helped me recognize ways in which human lives and this non-human entity's lives are interconnected.
RF04	Using the persona helped me see this non-human entity as part of a shared world rather than as something separate from human life.
Willingness to Use (WTU) — Behavioral Intention Outcome	
WTU01	After using the persona, I feel better equipped to account for this non-human entity's needs in my decision-making.
WTU02	Using the persona gave me concrete insights I could apply when making decisions that affect this entity or its habitat.
WTU03	I would consult this persona when considering how a decision might impact the non-human entity it represents.
WTU04	Using the persona changed or refined how I would approach a decision that involves this non-human entity.

Note. All items rated on a 5-point Likert scale (1 = *Strongly Disagree* to 5 = *Strongly Agree*). The NH-PPS core scale (RC, EC, CC, RO, PT; 20 items) should be administered whenever non-human personas are evaluated. Outcome measures (EO, RF, WTU; 12 items) should be added when assessing intervention effectiveness. Subscale scores are computed as the unweighted mean of the constituent items. EO and RF are primarily mediated through Perspective-Taking (PT); WTU is driven more directly by persona quality (RC, EC, CC, RO). See Table 12 for administration guidance.

So, three considerations play a role when adopting constructs from the NH-PPS: (1) purpose of evaluation (e.g., evaluating persona quality vs. its effects), (2) type of non-human persona being evaluated, and (3) evaluators' level of expertise about the non-human entities that the non-human persona represents. In addition, items may be slightly modified to accommodate different persona designs, by when doing so, extra attention is required to ensure that the conceptual meaning of the construct remains unaltered.

Table 12 summarizes the recommended use of each construct.

5.3 Limitations and Future Work

The study has limitations. First, the study presents a *preliminary instrument* whose dimensionality needs to be confirmed using a larger sample. The validation exercises done here are exploratory and should be expanded further, with a larger and more varied sample of evaluators but also testing the NH-PPS across different non-human entities (e.g., earth, sea, AI agent personas) and persona designs (e.g., profiles, narratives). Some of the items in the NH-PPS might not apply to all non-human entities (e.g., WTU01 speaks about "needs" but AI agents might not have needs in the biological sense) and some of the items are geared toward chat interaction with

Table 12: Recommended use of NH-PPS and outcome constructs in applied settings. It is possible to use NH-PPS partially, and its different parts can inform researchers about different facets of users' interaction with non-human personas.

Construct	What It Tells You
Persona Quality (20 items)	
RC (4 items)	Is the persona credible and grounded?
EC (4 items)	Is the persona ecologically plausible?
CC (4 items)	Is the persona clear and accessible?
RO (4 items)	Is the persona sufficiently complete?
Mechanism (20 items)	
PT (4 items)	Does the persona shift perspective?
Outcomes (12 items)	
EO (4 items)	Does it increase ecological concern?
RF (4 items)	Does it shift relational framing?
WTU (4 items)	Would people use this persona?

the persona (e.g., CC01 speaks about "persona's communication" but phrasing like "information" could be better when testing a static persona profile, for example). Therefore, future work should repeat the validation exercises here with a larger sample and perform additional analyses, including a confirmatory factor analysis and nomological validity testing, while adjusting the items to enable a broader applicability of non-human entities and persona designs.

Second, NH-PPS is currently designed for species with at least some degree of ecological complexity. Representing microorganisms or very simple organisms as personas raises additional challenges around the meaningfulness of some constructs (e.g., perspective-taking), which may require that construct adaptation is studied and applied more selectively given ecological complexity. We did *not* test the scale with organisms of minimal complexity—this would make an interesting research direction to pursue in future work. A related consideration here is that people's perceptions of non-human entities are likely to vary strongly by factors like *biological distance* (e.g., humans are mammals, so mammal behaviors are "easier" to understand, panda bears appear more "cute" than wolves to many people, and so on). Some species are extremely far from humans and, thus, the properties NH-PPS should be studied broadly across different families of species.

Third, NH-PPS measures *user perceptions*, not the objective quality of the ecological information conveyed by the persona. For example, a user might rate representational consistency highly even if the persona contains ecological inaccuracies, and *vice versa*; this depends on the user's level of knowledge and confidence, which are factors susceptible to bias. Coincidentally, this might explain why the ecological consistency items showed the weakest factorial structure in our sample; since our sample consisted of mainly non-experts with limited knowledge of the species, the participants might have felt uncertain about evaluating the species' ecological consistency, thus themselves answering inconsistently. What this tells us is that future NH-PPS validation efforts should recruit non-human entity experts, particularly to investigate if the ecological consistency construct behaves differently among expert and non-expert evaluators.

Fourth, because each participant contributed two ratings, one per persona, results should be interpreted with this dependency in mind. To account for this risk, we conducted separate analyses on first-rated and second-rated personas (as a reminder, all participants interacted with Wolf and Snail, in randomized order). The validation results were consistent with using the stacked 48 observations. For brevity, these results are reported in the online appendix[8]. However, since the main results apply the stacked observations, this is a methodological limitation that should be acknowledged.

Fifth, it is vital to note that, specifically for non-human personas, chat-based interaction offers both opportunities and risks, as noted in nascent research [47]. The main opportunity for interaction is that dialogue allows users to explore the species' perspective in an open-ended, self-directed way. This opens more learning opportunities about species than persona profiles, which are based on fixed narratives predetermined by the persona developer. Therefore, the interaction itself is likely to shape the formation of the perceptions. We do not study the effect of interaction on the formation of user perceptions of non-human personas, but highlight it a potentially impactful future research direction. For example, future work could apply NH-PPS in the context of static persona profiles and simultaneously evaluate how users' perceptions of non-human personas vary between chat and profile interfaces, as these persona designs are based on substantially different interaction paradigms.

Finally, future work should examine whether the NH-PPS is sensitive to changes in the information content of the non-human persona. For example, it is important to investigate whether personas grounded in richer ecological data produce higher representational completeness and ecological consistency scores, as one would expect. Such studies would provide additional evidence of scale validity across various use cases for non-human personas, but also pave way to more effective design of non-human personas.

6 Conclusion

Non-human personas are an adaptation of traditional user persona methods used in design and HCI to represent and advocate for non-human stakeholders (e.g., animals, plants, ecosystems) impacted by design decisions. These personas aim to break human-centric perspectives, evoke empathy for nature and its beings, and promote sustainable design choices. As HCI expands its scope beyond human users to encompass non-human entities as stakeholders, the methods and instruments developed for HCD require reconceptualization. We adapted the Persona Perception Scale, a commonly applied scale for persona evaluation, and modified its constructs and items beyond anthropocentric assumptions to make a new scale applicable to non-human personas. The NH-PPS proposed in this paper is based on making non-human entities accessible and actionable in human decision-making. The constructs in NH-PPS are designed to evaluate whether a non-human persona represents the reality of a non-human entity without flattening its otherness too much. The purpose of the NH-PPS is to help evaluate non-human persona designs by their ability to develop meaningful consideration of non-human interests. This work contributes to the broader

[8] https://osf.io/qyrm4/overview?view_only=81d06aa944fa44a48570ff183473002c

project of developing rigorous evaluation methods for more-than-human design, and we invite the research community to participate in the further empirical validation and refinement of the NH-PPS.

Declaration of Generative AI

During the preparation of this work, the author(s) used Anthropic's Claude 4.6 Opus to summarize and edit content, as well as to generate and run programming code. After using this tool, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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A Original Persona Perception Scale (PPS) Items

Table 13 reproduces the original PPS items as developed by Salminen et al. for evaluating human persona profiles. These items served as the conceptual starting point for the NH-PPS adaptation described in this paper.

B Work Task Scenario

> You and your business partners want to explore the possibility of creating a campsite in a forest in Eastern Finland. Your purpose is to turn this into a profitable business. The area you are looking at is a vast, remote forest area with beautiful nature and marshes. Before you proceed with the planning, you want to explore if the project would generate any harm toward species living in the Finnish forest. For some reason unknown to you, your mind fixates on two species: Eurasian gray wolf (Canis lupus lupus) and Narrow-mouthed whorl snail (Vertigo angustior) (later called wolf and snail). You are not an expert in these species but you become strongly fascinated by them, wanting to learn about their habits, behaviors, and how your business project would affect their circumstances. You do know that both species are endangered and could potentially put a stop to your project.
>
> Your task is to interact with the wolf and the snail personas to learn more about the species that these personas represent and then how your campsite might impact them so that you can design a more eco-friendly campsite.

C Overview of Scale Validation Methods

Table 14 provides a brief overview of each validation method referenced in Section 3.4.

Table 13: Original Persona Perception Scale (PPS) constructs and items.

Clarity	
CL01	The information about the persona is well presented.
CL02	The text in the persona profile is clear enough to read.
CL03	The information in the persona profile is easy to understand.
Completeness	
CM01	The persona profile is detailed enough to make decisions about the customers it describes.
CM02	The persona profile seems complete.
CM03	The persona profile provides enough information to understand the people it describes.
CM04	The persona profile is not missing vital information.
Consistency	
CN01	The quotes of the persona match other information shown in the persona profile.
CN02	The picture of the persona matches other information shown in the persona profile.
CN03	The persona information seems consistent.
CN04	The persona's demographic information (age, gender, country) corresponds with other information shown in the persona profile.
Credibility	
CR01	The persona seems like a real person.
CR02	I have met people like this persona.
CR03	The picture of the persona looks authentic.
Empathy	
EM01	I feel like I understand this persona.
EM02	I feel strong ties to this persona.
EM03	I can imagine a day in the life of this persona.
Likability	
LK01	I find this persona likable.
LK02	I could be friends with this persona.
LK03	This persona feels like someone I could spend time with.
LK04	This persona is interesting.
Similarity	
SM01	This persona feels similar to me.
SM02	The persona and I think alike.
SM03	The persona and I share similar interests.
SM04	I believe I would agree with this persona on most matters.
Willingness to Use	
WTU01	I would make use of this persona in my task of [insert task].
WTU02	I can imagine ways to make use of the persona information in my task of [insert task].
WTU03	This persona would improve my ability to make decisions about the customers it describes.

Table 14: Summary of scale validation methods and their purpose.

Category	Techniques
Reliability	• **Cronbach's α**: Quantifies internal consistency by estimating the proportion of variance in composite scores attributable to the true score.
Sampling adequacy	• **Kaiser–Meyer–Olkin (KMO) measure**: Compares observed to partial correlations among items to determine whether the correlation structure is sufficiently strong and patterned to support factor analysis.
Structural validity	• **Exploratory Factor Analysis (EFA)**: Uncovers the latent factor structure underlying a set of observed items, identifying the number of factors and the pattern of item–factor loadings without imposing a predetermined structure.
Convergent validity	• **Average Variance Extracted (AVE)**: Measures the mean proportion of variance in observed items explained by their latent factor, indicating whether a construct captures more variance in its indicators than is due to measurement error. • **Composite Reliability (CR)**: Assesses the overall reliability of a set of heterogeneous but related items loading on the same construct.
Discriminant validity	• **Fornell–Larcker criterion**: Requires that the square root of each construct's AVE exceed its correlation with every other construct, ensuring a construct shares more variance with its own indicators than with those of other constructs. • **Heterotrait–Monotrait (HTMT) ratio**: Estimates the ratio of between-trait to within-trait correlations to test whether theoretically distinct constructs are also empirically separable.